POWER PLANT ENGINEERING

ENGINEERING AND MAINTENANCE MAGAZINE FOR POWER AND INDUSTRY

HOW TO STORE AND HANDLE COAL

In this Issue

STORING COAL SAFELY — BY M. E. DREWRY

FOR THE SMALL PLANT — BY CARROLL B. HARDY

THE STORAGE PROBLEM — BY GEORGE C. DARLEY

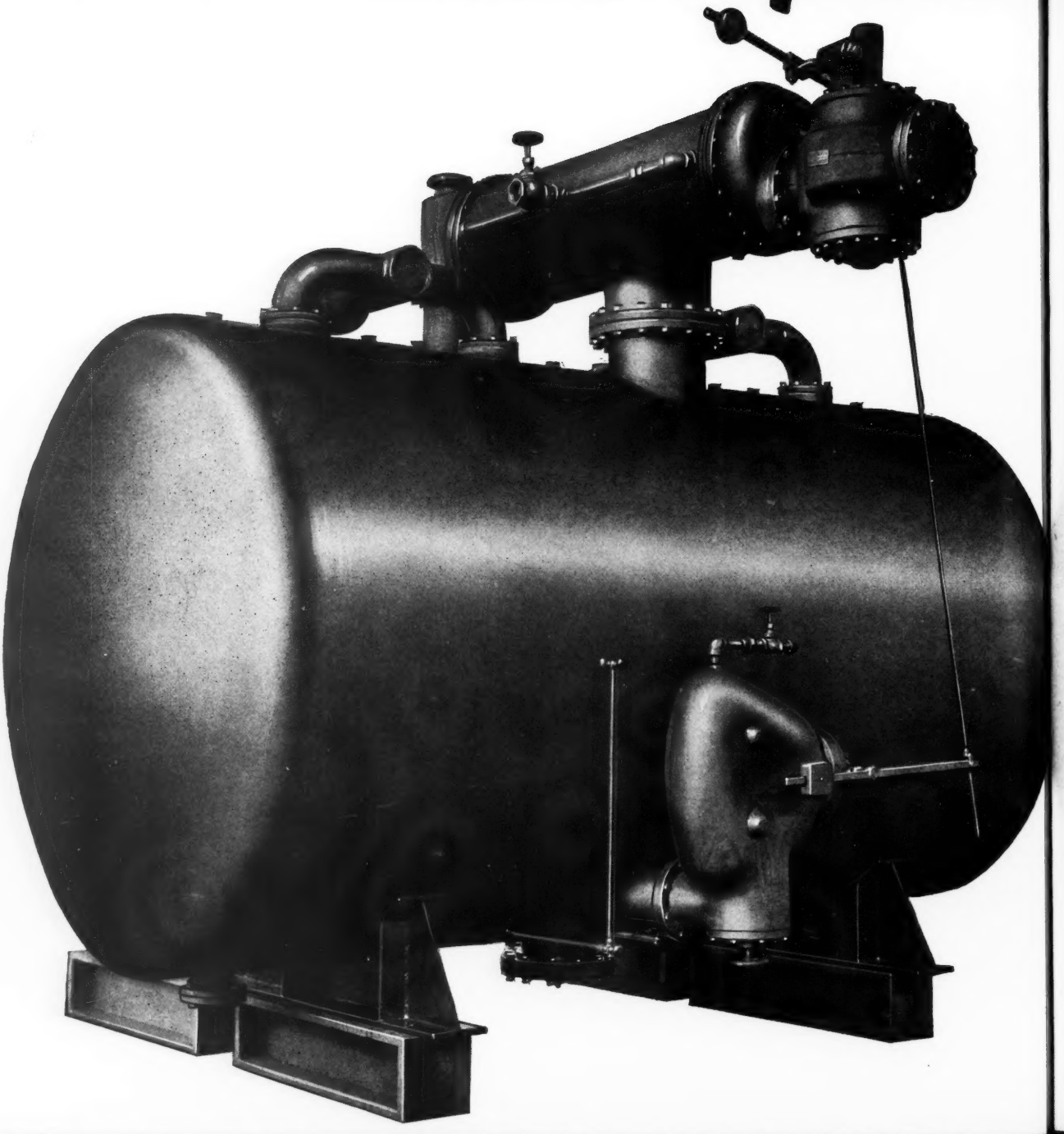
HANDLING AND PREPARATION — BY JOSEPH HARRINGTON

FOR THE LARGE PLANT — BY RAYMOND J. BRANDT

OTHER PLANT PROBLEMS — Listed in Table of Contents—Page 373

July 1942

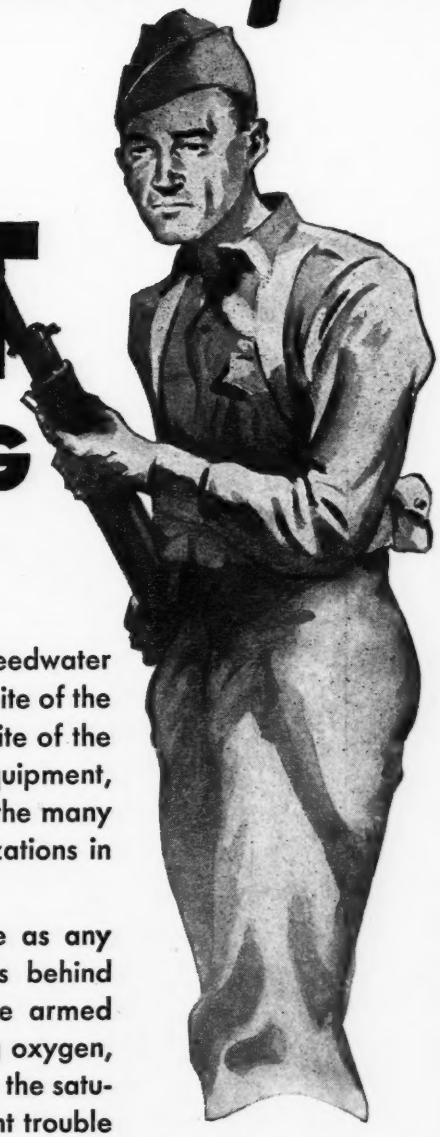
On Guard *against*



ELLIOTT COMPANY

Deaerator and Heater Department
JEANNETTE, PA.
District Offices in Principal Cities

...Nature's Sabotage!



ELLIOTT
DEAERATING HEATERS

in scores of ordnance plants are removing from boiler feedwater the corrosive element, oxygen. It is a notable fact that in spite of the speed with which these plants have been constructed, in spite of the need for elimination of all but absolutely essential equipment, Elliott deaerating heaters have been used in every one of the many plants of this type built by one of the best known organizations in the country.

Oxygen in feedwater can be as insidiously destructive as any "fifth columnist" or enemy agent, in the steam plants behind America's war production. Elliott deaerating heaters, like armed guards at the gates, prevent the intrusion of trouble-causing oxygen, delivering oxygen-free feedwater, which is also heated to the saturated temperature of the steam supplied. They thus prevent trouble while serving most efficiently as a heater.

It pays in every case to install Elliott *deaerating* heaters. They are designed and built to meet the conditions under which they operate in the individual plant.

N-966

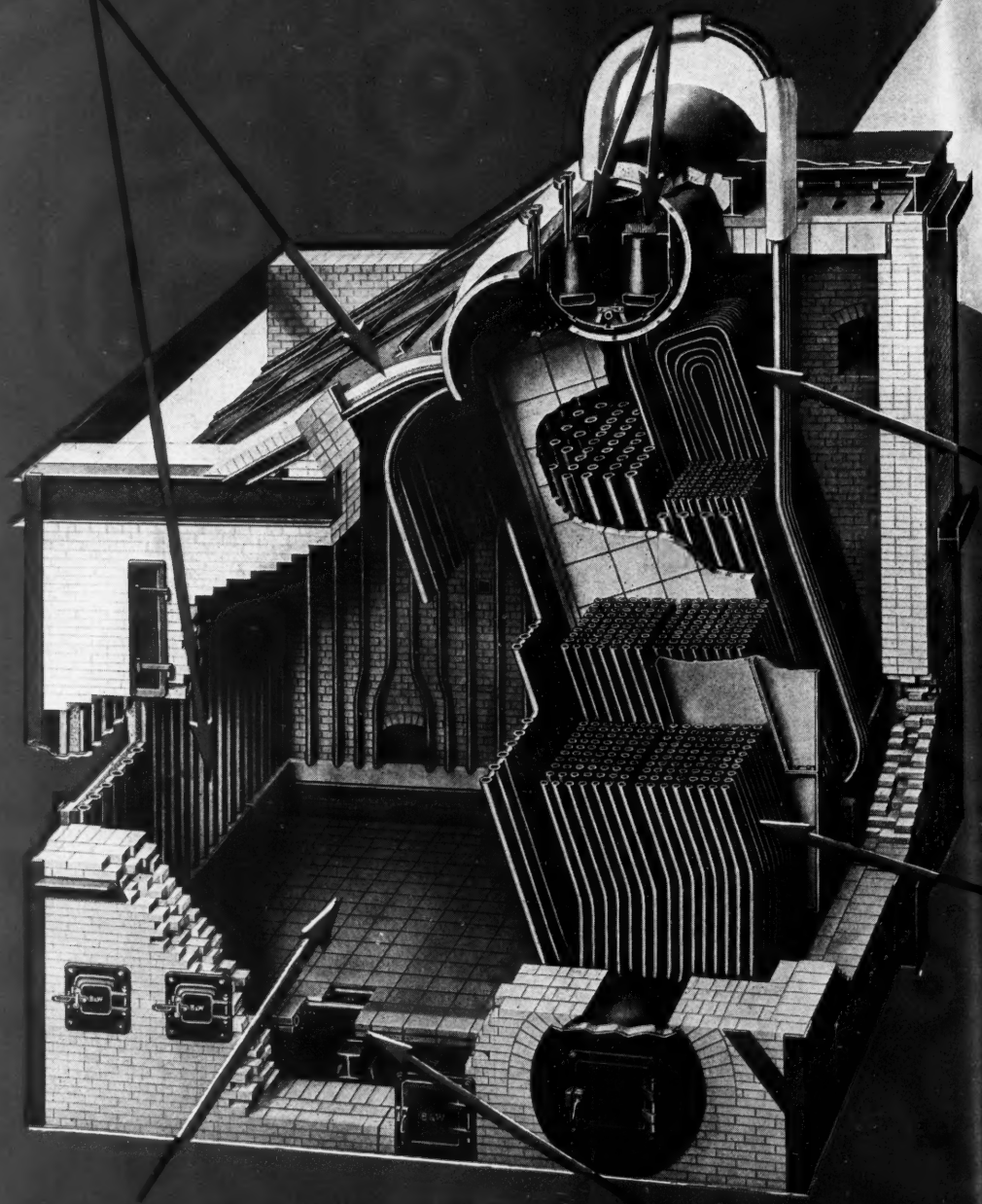
Y Equipment on the war path:

TURBINE-GENERATORS • MECHANICAL DRIVE TURBINES • ENGINES
ENGINE-GENERATORS • MOTOR-GENERATORS • MOTORS
GENERATORS • CONDENSERS • STEAM JET EJECTORS
DEAERATORS • FEED-WATER HEATERS • DEAERATING HEATERS
CENTRIFUGAL BLOWERS • TURBOCHARGERS • DESUPERHEATERS • STRAINERS
SEPARATORS • GREASE EXTRACTORS • NON-RETURN VALVES • LAGONDA-LIBERTY TUBE CLEANERS

✓R v.46² Jy-D 1942

The water-cooled furnace sidewalls and roof are of the same durable stud-tube construction that is used in large central-station boilers.

Cyclone Steam Separators provide dry steam at high boiler water concentrations, independently of wide variations in water level, increase circulation by eliminating steam from the down-flowing circulating water, and allow a more nearly correct water-level indication.



The deep furnace, fired from one end, provides ample space for complete combustion with minimized surface fouling, resulting in high rates of radiant absorption by the wall surfaces.

The bare metal blocks, which cover and protect the tubes of the water-cooled furnace floor, provide a surface readily cleared of ash.

Tech

AT YOUR SERVICE TOO—
B & W
INTEGRAL FURNACE
BOILERS

TRADE MARK REG. U.S. PAT. OFF.

One hundred and one B&W Integral-Furnace Boilers have been purchased for central-station service by fifty-six utilities. Of these purchasers, eighteen, or 34 per cent, have ordered additional units on the strength of the performance of the original installations.

These repeat orders based on experience constitute approximately 36 per cent of the total number of these boilers purchased for central-station use.

This outstanding record of the Integral-Furnace Boiler for availability under all conditions of load, steam characteristics, and most methods of firing indicates its ability to serve satisfactorily under all the usual conditions of central-station service.

G-2297

The Navy "E" Award to the Barberton Works for production achievement is "an honor not lightly bestowed and one to be cherished."

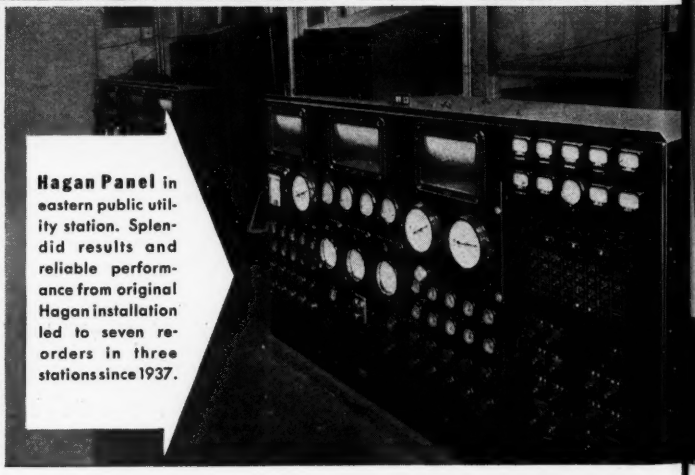
BABCOCK & WILCOX

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET NEW YORK, N. Y.

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago, Ill., U. S. A. Subscription price, $2.00 a year. Single copies current issue, 25c. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill. under act of March 3, 1879. Vol. XLVI, No. 7.

HOW MUCH OF YOUR P

Hagan Master Sender functions instantly with slightest changes in steam header pressure. Air-operated Hagan Control assures fast, positive action, freedom from trouble in service.



Hagan Panel in eastern public utility station. Splendid results and reliable performance from original Hagan installation led to seven reorders in three stations since 1937.

POWER GOES UP IN SMOKE?

WHEN *production* counts, efficiency often tailspins, and the smoking stacks resulting sky-write a story of improper combustion, wasted fuel and power—all in an effort to get more steam.

But the price is costly.

Anything that interferes with maximum heat development in the furnace or prevents the most efficient heat absorption will lower boiler performance. Fuel-air ratio, heat absorption, air-supply control and clean heating surfaces are but a few of the factors with which alert operators are now concerned—how to increase output *without* loss of efficiency.

One means to that end—and a very effective one, too—is Hagan Automatic Combustion Control. Here is how Hagan Control can help you stretch *your* boiler capacity:

1. It produces the maximum quantity of steam from any given fuel by introducing fuel and air to the furnace in *correct* proportions for utmost efficiency.
2. It insures that the steam produced shall have *utmost* utilization value, in accordance with steam demand.
3. It insures maximum steam output from boilers of varying capacities, through *proper* distribution of load among the units in service.
4. It materially reduces soot-blowing requirements, providing *more* steam for productive work.

Other important advantages of Hagan Control under today's conditions include: reduced furnace maintenance, protection against excessive repairs to fuel burning equipment, relief from labor shortages, and increased safety of operation.

In addition, Hagan Control can be installed in a relatively short while—all that is needed in many plants to surmount peak-production hurdles.

For *more* production, and *less* sky heat, with *increased* efficiency, therefore, call in a Hagan combustion specialist . . . now!

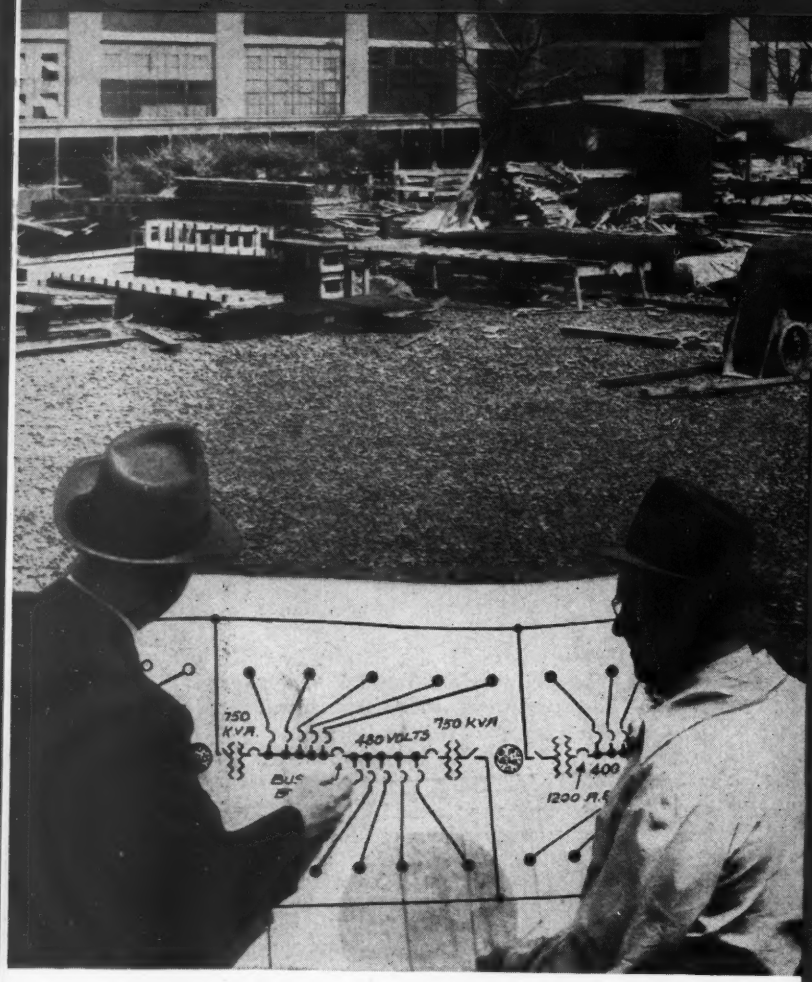
HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH, PA.

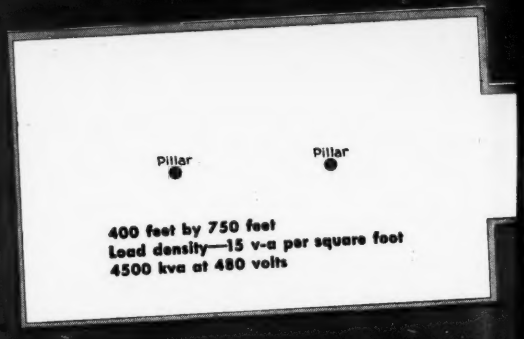
SPECIFIC ADVANTAGES OF HAGAN AUTOMATIC COMBUSTION CONTROL

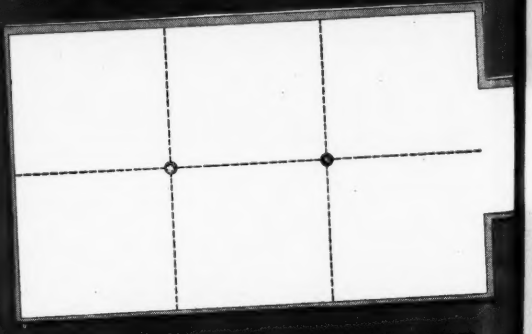
Simplicity of operation.
Ease of installation.
Ruggedness of equipment.
Sensitivity to small load changes.
Accuracy of adjustments for small variations.
Speed of movement, with stability, throughout operating range.
Flexibility in meeting individual plant conditions.
Engineered by the pioneers and leaders in automatic combustion control.

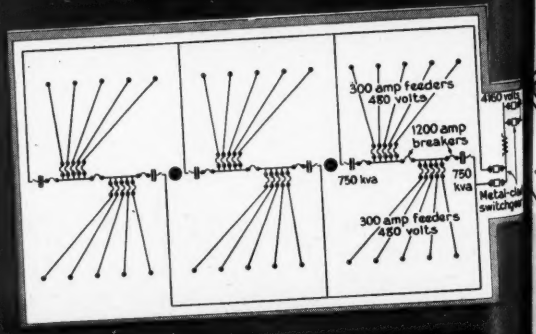
HAGAN *Automatic* COMBUSTION CONTROL
The pioneer . . . and still the leader

How to PROVIDE PLANT POWER QUICKLY









Take these 3 simple steps and you can order switchgear equipments and unit substations at an early stage of construction—*save weeks of time.*

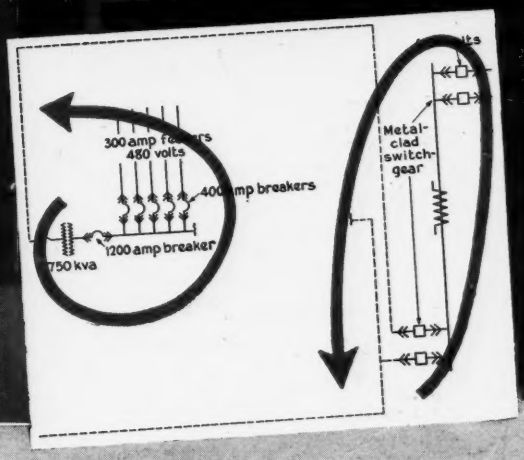
1. ***Calculate the total kva you need*** Load densities commonly range from 5 to 25 volt-amperes per square foot of floor area. Assembly areas usually fall in the lower range, intensive manufacturing areas in the upper range. Your consulting engineers can help you to predict your load density accurately.

2. ***Divide the load area into separate load zones of 500, 750, or 1000 kva***

3. ***Divide the load of each zone into feeder loads***—and draw a one-line diagram of your proposed load-center system, showing the functions to be performed and the ratings required.

Now, with this one-line diagram, you can immediately order your switchgear and unit substations.

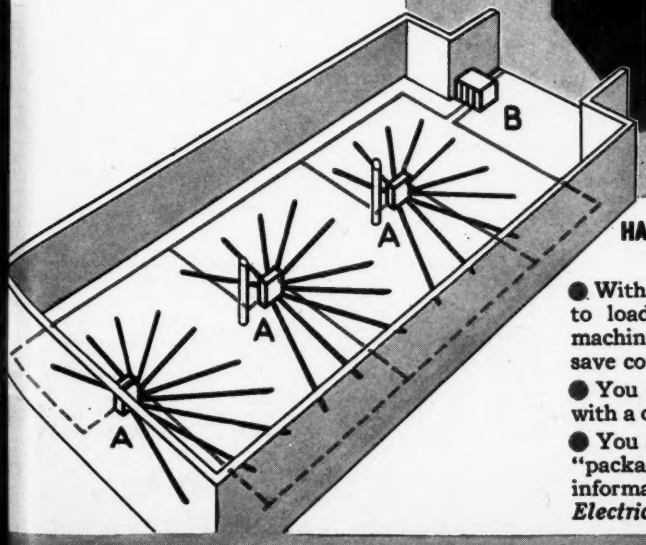
A SIMPLE ONE-LINE DIAGRAM PUTS US TO WORK ON STANDARD EQUIPMENTS



A ***Load-center Unit Substations***— including transformer and high- and low-voltage protective and disconnecting devices, all co-ordinated as a single, safe, compact, easy-to-install unit.

B ***Metal-clad Switchgear Equipments***—for protecting primary circuits up to 15 kv. A safe, co-ordinated assembly of breakers, instrument transformers, buses, and associated equipment.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.



HAVE LOAD-CENTER POWER BEFORE THE FIRST MACHINE IS READY TO ROLL

● With load-center distribution, power at high voltage goes right to load-center unit substations, and then directly to your machines through *short* low-voltage secondary feeders. You save copper, steel and dollars.

● You can order *standard* G-E load-center equipments *early*—with a one-line diagram. Get everything you need—weeks sooner.

● You get them ready to set in place and connect—in compact "packages" that can be put in otherwise "dead" area. For full information, contact your nearest G-E Office, or write *General Electric, Schenectady, N. Y.*

GENERAL ELECTRIC

854-17-7300

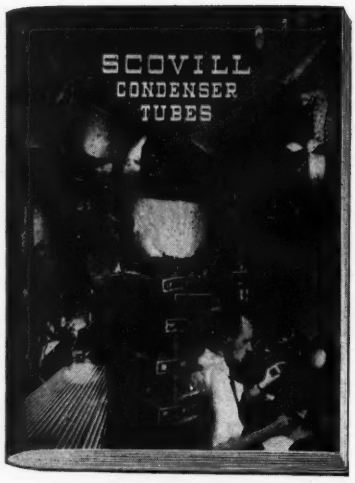
Suggestions for Prolonging Condenser Tube Service Life

Now, more than ever, condenser tube dependability and long life are factors of importance, both from the angle of uninterrupted service and the conservation of copper alloys.

In these respects, Scovill facilities will prove to be valuable to you, for Scovill offers one product—and three services.

The first service is *men*—Scovill engineers who can help you get the most out of your present tubes—then can suggest the most economical retubing alloy for your operating conditions. With a practical understanding of condenser and heat exchanger problems, these men can be of help to you on any problem pertaining to tube use. The service is free—we hope you will use it.

The second service is *manuals*. Have us send you a copy of the Condenser Tube Booklet illustrated—a source of valuable information on prolonging condenser tube service life. Write Scovill Manufacturing Company, 17 Mill Street, Waterbury, Connecticut.



The third service is *metals*. Scovill has a condenser and heat exchanger tube alloy to meet every need where a nonferrous alloy tube can be used:

MUNTZ METAL

For steam condensers and other low-temperature, low-pressure heat exchangers where raw water is fresh and low in temporary and permanent hardness and in dissolved gases (CO_2 and O_2), as, for example, many locations on the Great Lakes and a few inland rivers.

COPPER

For steam condensers where fresh water is used, and particularly with relatively soft waters carrying high concentration of dissolved gases (CO_2 and O_2); where the conditions of operation are such as to cause "dezincification" in the brasses. Copper tubes are also frequently used in heat exchangers not requiring great physical strength and where sulphur compounds and oxidizing acids are absent. Pure copper softens at approximately 200° C.

Considering the importance of economizing the use of copper for the war program, we suggest your consideration of "Phosphorized Admiralty Tubes" (with their lower copper content) for installations where copper would normally be used.

ARSENICAL COPPER

The addition of the 0.15% to 0.75% Arsenic to pure copper raises

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL
one product . .
SERVICE IN MANUALS.

its softening temperature so that it can be used in heat exchangers operating at temperatures up to 300° C. Hard drawn Arsenical Copper tubes have approximately the same strength as "finish annealed" Admiralty or Muntz tubes. They are usually supplied in the hard condition with ends annealed if necessary. Both laboratory tests and field service of this material indicate an improvement in corrosion resistance over previously used type of copper.

"Phosphorized Admiralty Tubes" will perform satisfactorily in most installations where Arsenical Copper is usually used. This substitution is particularly desirable now as "Phosphorized Admiralty" requires 30% less copper.

RED BRASS

For condensers and heat exchangers where it is necessary to combat "dezincification" and where acidity, if any, is of a low order. Red Brass is stronger and stiffer than copper and has excellent resistance to "dezincification" in fresh waters high in temporary and permanent hardness and in soft waters carrying high concentrations of dissolved gases (CO_2 and O_2).

"Phosphorized Admiralty Tubes" will also be a satisfactory material for these conditions. In the present tight copper situation, we suggest your use of "Phosphorized Admiralty" with its lower copper content.

ADMIRALTY

Regular

For condensers and other heat exchangers where raw water, whether fresh, brackish or saline, pure or polluted, ranges from moderately acid to alkaline. Regular Admiralty has excellent strength and ductility at temperatures up to 200° C. (390° F.) where a slight drop occurs.

"Phosphorized"*

Wherever dezincification of Regular Admiralty Tubes has been a corrosion problem, the use of Phosphorized Admiralty is suggested. This alloy combines the general excellent corrosion-resistant properties of Regular Admiralty, a desirable fine grain structure, and very marked resistance to dezincification. Several million pounds of Phosphorized Admiralty Tubes are now in service and reports of their ability to withstand both general corrosion and dezincification have been very favorable. (Priced the same as Regular Admiralty.)

ALUMINUM BRASS

In many installations where tube deterioration results from impingement (erosion-corrosion) attack, this alloy has proved superior to Admiralty. The alloy can be used with salt, brackish or fresh water at normal temperatures. The desirable corrosion-resistance properties probably result from the formation of a tough, thin, continuous film of aluminum oxide which forms on the exposed surface.

Principal uses to date and best performances have been in the marine field and tidewater plants where saline waters are encountered.

CUPRO NICKEL 70-30

Recommended for the most severe conditions in which copper alloys are serviceable. The protective film formation on this alloy is impervious, tough, and continuous. It protects against the chemical or electro-chemical action of the commonly encountered circulating media in power, petroleum, and other process plants. Erosion-corrosion resistance is of a high order.

*"Phosphorized Admiralty Tubes" for condenser and heat exchanger service are covered by patent 2,224,095 and can be legally supplied only by Scovill Manufacturing Company, the owner of this patent.

Scovill, for many years a regular source of supply for the U. S. Government, is cooperating in every way to forward defense plans. When deliveries are not as prompt as our customers desire, we hope they will realize that delays are sometimes unavoidable, and part of the price paid for National Defense.

Condenser Tubes

. . . three services

SERVICE IN METALS . . . SERVICE IN MEN

THREE "S-A" BOILERS

Operating night and day to fuel the Allied Nations, two of the three boilers receive no protection from weather except a small corrugated roofing over the control board and burners.

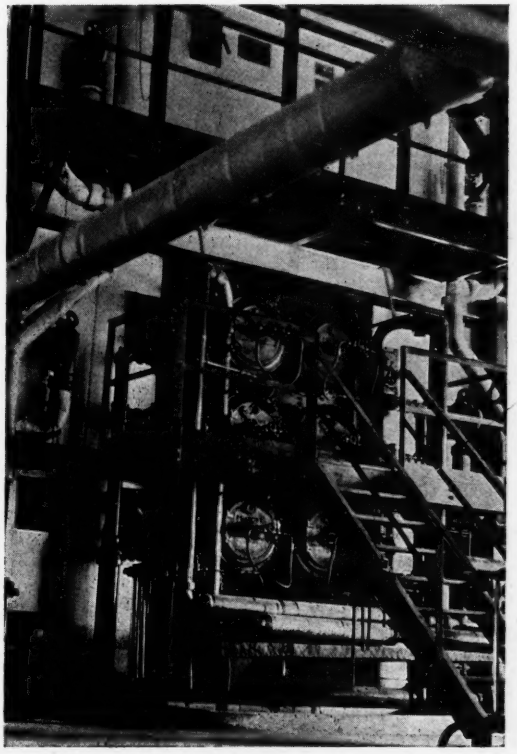
These units, each of 75,000 pounds steam per hour at 195 pounds pressure and 50 degrees superheat, show an efficiency of 77.3 per cent without heat recovery equipment when burning refinery gas fuel.

Low installation cost was obtained by constructing for outdoor service as mild climatic conditions prevail at this world renowned refinery. Two of the steam generators—as illustrated—are provided with weather proof steel casings, designed with ample provision for expansion and contraction, thoroughly insulated, and effectively flashed to prevent casing leakage.

FOSTER WHEELER CORPORATION

FOSTER

S FOR OIL REFINERY



TROUBLE FREE OPERATION

CHIEF FACTOR IN SELECTION OF

"S-A" DESIGN

Firing front of the third steam generator which is equipped with a small extended surface economizer. Burners use either gas or oil fuel and give efficiency of 79 per cent with refinery gas. Capacity 60,000 lb. steam per hr. at 300 lb. pressure with F.S.T. 688° F.

Located hundreds of miles from sources of supplies and replacements, the importance of easy repair, simplicity and dependability was of paramount importance to the refiner. The selection of three Foster Wheeler "S-A" units is a definite recognition of preeminence in these qualifications.

In addition to these important operating advantages, the engineering design and construction embody progressive characteristics including:

→ 1. Long gas travel for complete combustion.

→ 2. Sufficient cooling of gases in furnace to prevent slagging.

→ 3. Minimum amount of refractory setting.

→ 4. High efficiency.

→ 5. Compactness of design and low headroom.

→ 6. Exceptionally low draft loss.

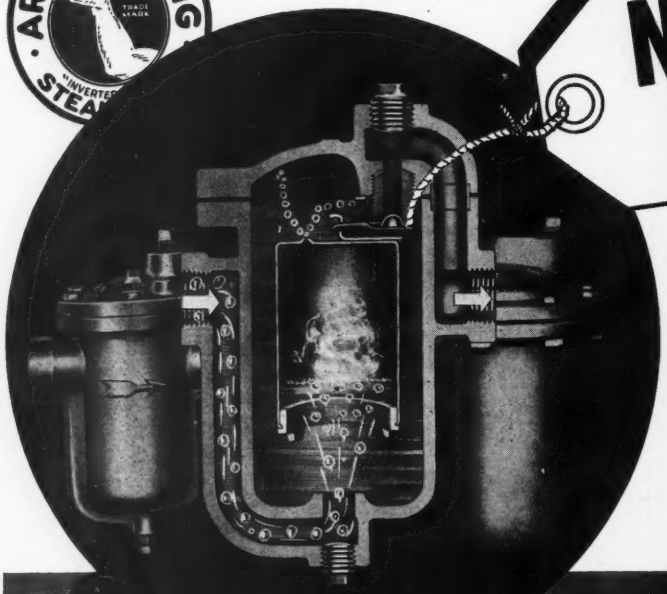
165 BROADWAY, NEW YORK, N. Y.

WHEELER

NO STEAM LEAKAGE

with

- **LIGHT LOADS**
- **HEAVY LOADS**
- **FLUCTUATING LOADS**
- **INTERMITTENT LOADS**
- **NO LOAD**



JUST HOW IMPORTANT IS THIS ADVANTAGE?

YOU BE THE JUDGE!

TABLE A. Showing cost of various sized steam leaks at 100 pound pressure. (assuming steam costs 50 cents per 1000 lbs.)

Size of Orifice	Lb. Steam Wasted Per Month	Total Cost Per Month	Total Cost Per Year
½"	835,000	$417.50	$5,010.00
⅜"	470,000	235.00	2,820.00
¼"	210,000	105.00	1,260.00
⅛"	52,500	26.25	315.00
1/16"	13,200	6.60	79.20
1/32"	3,400	1.70	20.40

(For steam at 50 pounds pressure, the waste is about 75% of the above figures; at 20 pounds, it is about 50%; and at 5 pounds, the loss is about 25%.)

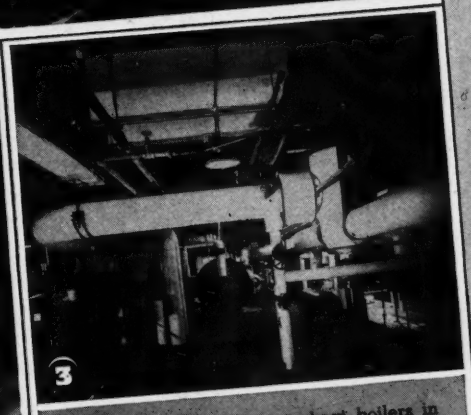
NOW is no time for any plant to be harassed by steam losses. Use of traps with leaky valves or traps of a type that won't close tight under variable load conditions constitutes a real menace to American industrial production capacity. How widespread such losses have become is indicated by the long list of installations where Armstrong traps have CUT FUEL COSTS . . . CUT BACK PRESSURE IN RETURN LINES . . . CUT LOAD ON BOILERS, in addition to raising temperatures and reducing maintenance expense.

Armstrong Steam Traps handle ANY load without loss of live steam —thanks to Armstrong's original development of the inverted bucket operating principle. Ability to give this kind of service is a direct result of quality construction and superior design. You get this kind of quality and performance in every Armstrong trap from the smallest up. Catalog on request.

ARMSTRONG MACHINE WORKS
810 Maple Street Three Rivers, Michigan

ARMSTRONG *Inverted Bucket*

Pre-Fabricated and Erected by MIDWEST

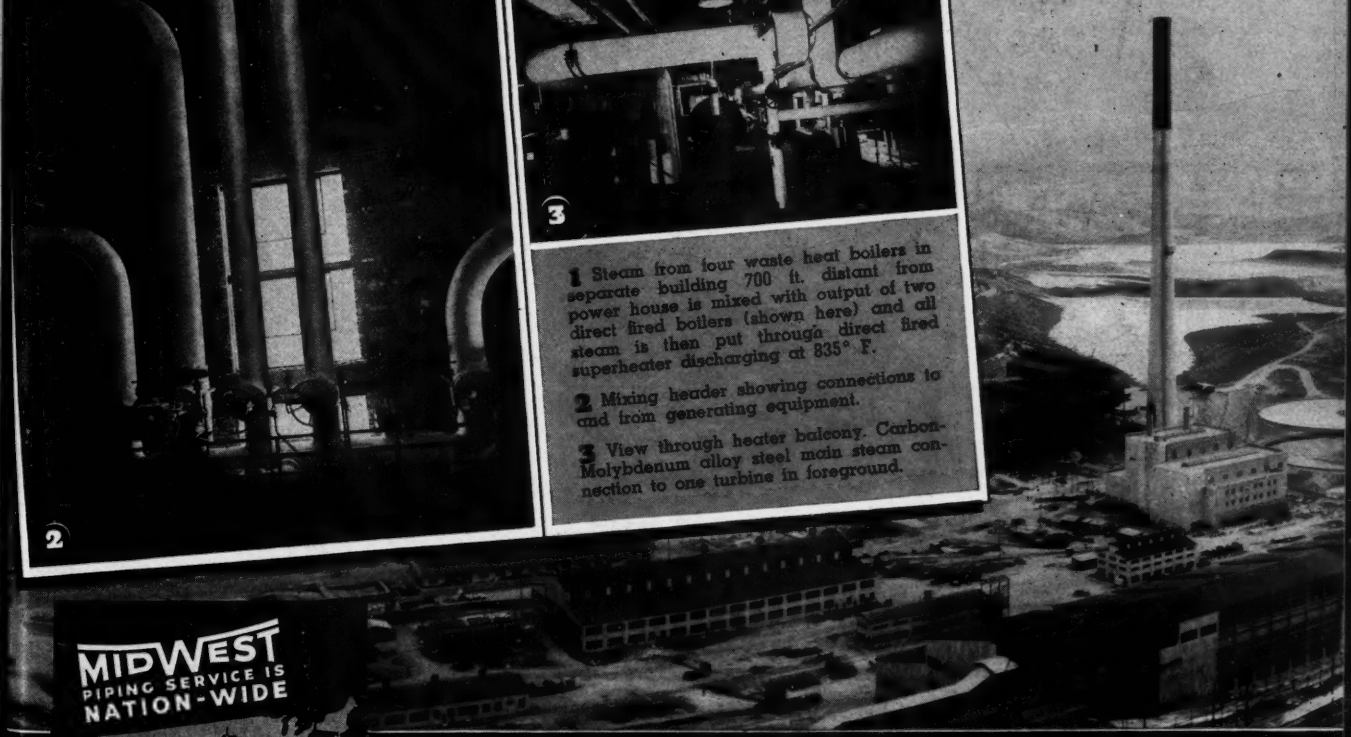


1 Steam from four waste heat boilers in separate building 700 ft. distant from power house is mixed with output of two direct fired boilers (shown here) and all steam is then put through direct fired superheater discharging at 835° F.

2 Mixing header showing connections to and from generating equipment.

3 View through heater balcony. Carbon-Molybdenum alloy steel main steam connection to one turbine in foreground.

Piping for both power house and waste heat boiler plant of the new Morenci Plant of the Phelps Dodge Corporation was furnished and erected by Midwest. This piping was shop-prefabricated insofar as advanced engineering practices would permit and then delivered to the job in a series of accurate sub-assemblies for rapid erection. Morenci power piping is representative of the work done by Midwest . . . three modern fabricating plants and an erecting organization operating from coast-to-coast.



MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo. Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—949 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—520 Anderson St.
New York—(Eastern Division) 30 Church St. • San Francisco—535 Call Bldg. • Tulsa—533 Maye Bldg.

DON'T OVERLOOK RESULTS LIKE THIS WITH A-E-CO TAYLOR STOKERS

PROBLEM: The geographical location of a metal working plant made a wide range of Pennsylvania and Ohio coals economically available. The real problem was to select firing equipment capable of burning efficiently coals of widely diversified characteristics.

SOLUTION: After a careful investigation of all available equipment, Taylor Stokers were selected for the job. Two HC6 Taylor Stokers, 4 retorts, 25 tuyeres were placed under the 300 H.P. Stirling boilers.

RESULTS: The decision proved a sound one. During the first five years of service, stoker maintenance averaged less than 1¢ per ton of coal burned.

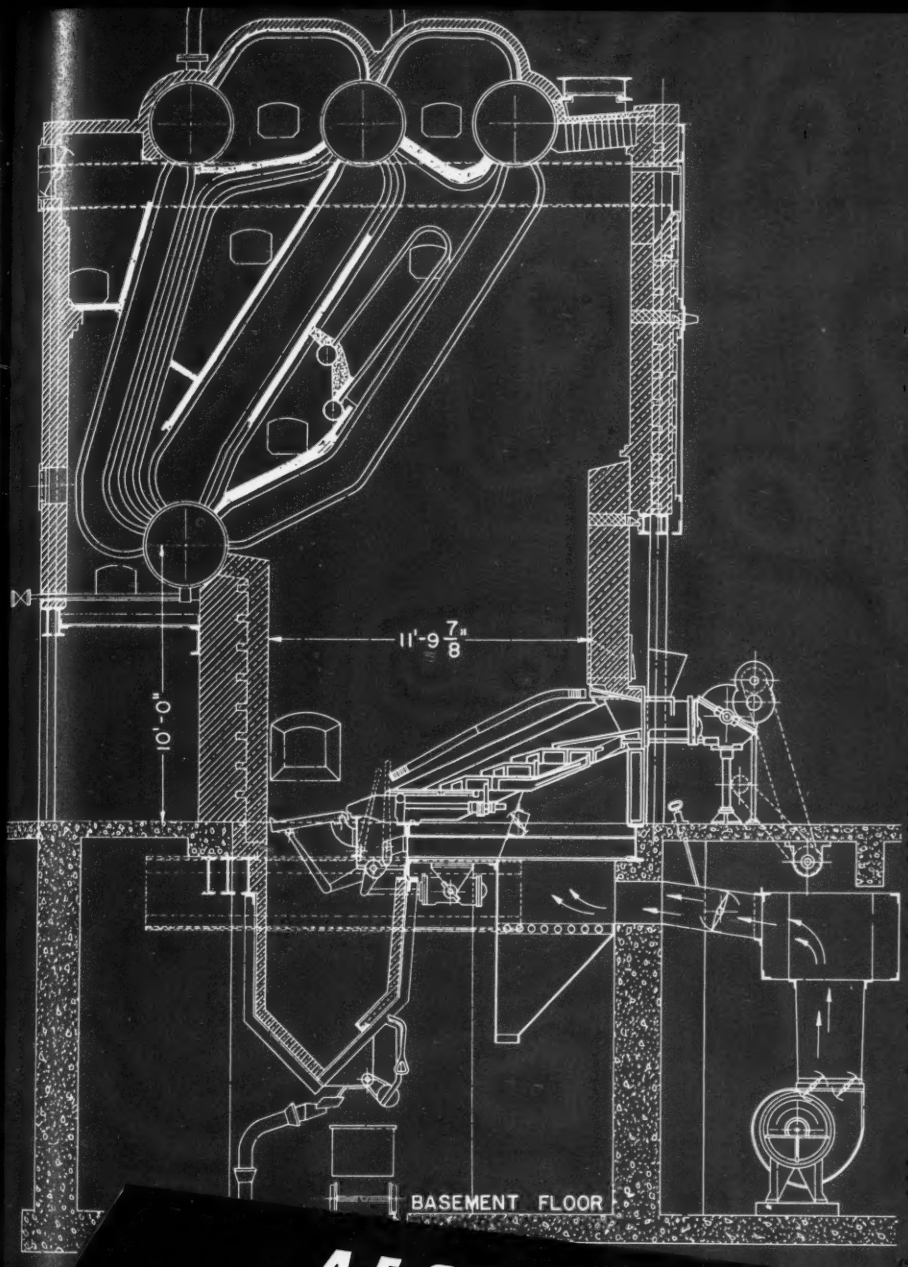
21 different grades of Pennsylvania and Ohio coals have been burned. Ash content varied from 7 to 12%; sulphur from 1 to 3.8%; B.T.U. from 12,000 to 14,000; ash fusing temperatures from 1950 to 2550°F. All coals were burned satisfactorily. Maximum boiler rating obtained: 350% for one hour; 300% for 24 hours. Average summer load: 185% of normal boiler rating. Average winter load: 275% of normal boiler rating.

Boilers were never out of service due to repairs or breakdowns. Operation was continuous except for brief vacation periods when the entire plant was shut down.

A CASE IN THE METAL WORKING INDUSTRY

AMERICAN ENGINEERING

PHILADELPHIA • PENNSYLVANIA



A-E-CO TAYLOR STOKERS ON THE FIRING LINE

*Aluminum Company of America, Edgewater, N. J.
*Aluminum Company of America, New Kensington, Pa.
American Tobacco Co. Inc., Durham, N. C.
Castanea Paper Company, Johnsonburg, Penna.
Chrysler Corporation, DeSoto Plant, Detroit, Mich.
*Collins and Aikman Corp., Roxboro, N. C.
City of Columbus, Ohio
*Consolidated Paper Company, Monroe, Michigan
*Cresson State Sanitarium, Cresson, Penna.
Defiance Milk Products Co., Defiance, Ohio
*DeLaval Steam Turbine Co., Trenton, N. J.
*Detroit Sulphite Pulp & Paper Co., Detroit, Michigan
City of Dover, Ohio
*Draper Corporation, Hopedale, Mass.
Erwin Cotton Mills Co., West Durham, N. C.
*Fisher Body Corporation, Detroit, Michigan
Fisher Body Corporation, Fleetwood Plant, Michigan
*Fisher Body Corporation, Grand Rapids, Michigan
*Fisher Body Corporation, Pontiac, Michigan
Fox Paper Company, Lockland, Ohio
Froedtert Grain and Malting Co., Milwaukee, Wisc.
*City of Galion, Ohio
*Gardner-Richardson Company, Lockland, Ohio
*General Electric Company, Erie, Penna.
*General Electric Company, Fort Wayne, Ind.
*Greenwood Electric L. & W. Plant, Greenwood, Miss.
*Board Public Works, Hannibal, Mo.
Hill School, Pottstown, Penna.
*Hobart Mfg. Co., Troy, Ohio
*City of Holland, Michigan
*Hope Natural Gas Co., Cornwell Station, West Va.
Hudepohl Brewing Co., Cincinnati, Ohio
Industrial Cotton Mills, Rock Hill, S. C.
*City Water & Light Plant, Jonesboro, Ark.
Kohler Company, Kohler, Wisc.
Maryland State Penal Farm, Roxbury, Md.
*Maybury Sanitarium, Northville, Michigan
Michigan Carton Company, Battle Creek, Michigan
*Michigan State College, East Lansing, Mich.
Municipal Light Plant, Marshfield, Wisc.
*Pacific Mills, Lyman, S. C.
*Packard Motor Car Co., Detroit, Michigan
*Municipal Electric Plant, Painesville, Ohio
*Park Drop Forge, Cleveland, Ohio
*Pennsylvania Electric Co., Seward, Penna.
*Pennsylvania R. R. Co., Philadelphia, Penna.
*Picatinny Arsenal, Dover, N. J.
*Pittsburgh Plate Glass Co., Barberton, Ohio
Borough of Quakertown, Quakertown, Penna.
Raleigh Wyoming Mining Co., Glen Rogers, W. Va.
Rhinelander Paper Company, Rhinelander, Wisc.
City of Richland Center, Wisconsin
*City of Richmond, Indiana
Sayles Biltmore Bleachery, Biltmore, N. C.
Scotten Dillon Company, Detroit, Michigan
Shelby Cotton Mills, Shelby, N. C.
Sloane-Blabon Corp., Philadelphia, Penna.
*Solvay Process Company, Detroit, Michigan
*St. Elizabeth's Hospital, Washington, D. C.
City of St. Bernard, Ohio
Swarthmore College, Swarthmore, Penna.
*Timken Roller Bearing Co., Canton, Ohio
Timken Roller Bearing Co., Gambrinus, Ohio
Municipal Water & Light Plant, Tippecanoe City, O.
City of Toledo, Ohio
Union Bleachery, Greenville, S. C.
Union Mills Paper Mfg. Co., New Hope, Penna.
*University of Wisconsin, Madison, Wisc.
*Vassar College, Poughkeepsie, New York
*Borough of Vineland, New Jersey
Warfield Natural Gas Company, Harold, Kentucky
White Sewing Machine Co., Cleveland, Ohio
Whiting Plover Paper Company, Stevens Point, Wisc.

(*) *Represents repeat orders.*

A-E-CO TAYLOR STOKER

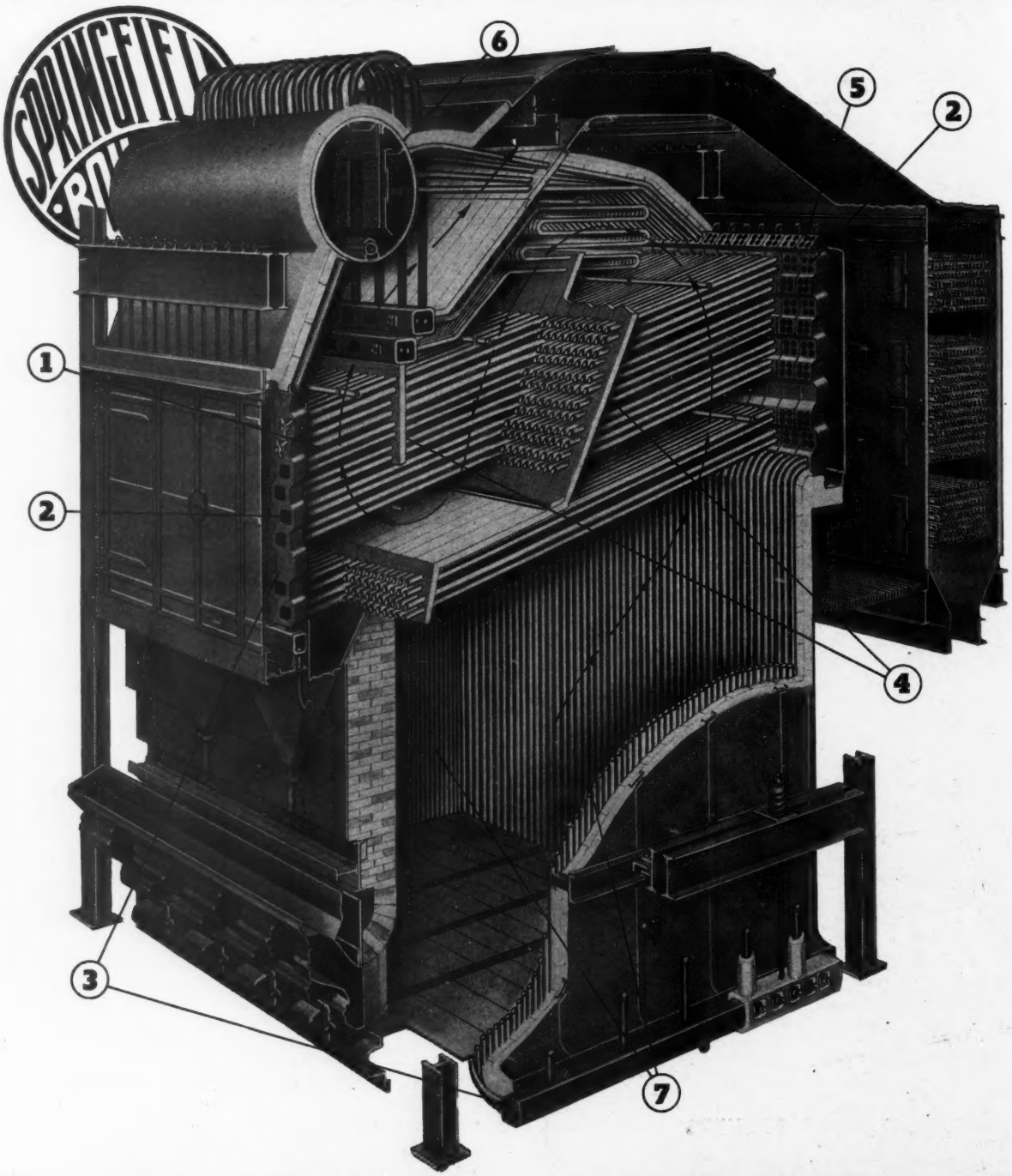
A-E-CO TAYLOR STOKERS
WATER WALLS · ASH HOPPERS
HELE-SHAW FLUID POWER
MARINE DECK AUXILIARIES
LO-HED HOISTS

COMPANY

BEFORE YOU BUY ANY FUEL FIRING EQUIPMENT CONSIDER EACH OF THESE 12 FACTORS

1. **RELIABILITY**—the ability to operate with minimum outage and minimum standby equipment.
2. **CAPACITY**—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.
3. **MAINTENANCE**—the ability to operate continuously with minimum repair costs.
4. **FLEXIBILITY**—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.
5. **EFFICIENCY**—the proved "dollar efficiency" (total cost of steam production) as shown by actual performance in similar installations.
6. **OPERATION**—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.
7. **ADAPTABILITY**—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.
8. **FUEL FLEXIBILITY**—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.
9. **REFUSE DISPOSAL**—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.
10. **STACK DISCHARGE**—the practical elimination of "smoke nuisance" without special equipment.
11. **SPACE REQUIREMENTS**—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.
12. **OBSOLESCENCE**—the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

FEATURES THAT MEAN



SPRINGFIELD

MODERN STEAM GENERATING UNITS

✓Easier MAINTENANCE
✓Longer Life • SAFETY
✓Greater AVAILABILITY

1 STRAIGHT TUBES. Experienced operating engineers will agree that there is nothing like a straight tube for CONVENIENCE! You can look through a Springfield tube and see that it is clean and unblemished. With one size of straight boiler tube, Springfield averages about 1/16 fewer tube sizes than common bent tube boilers.

2 4 TUBES GROUPED UNDER 1 HANDHOLE. Compared with the nuisance of having to crawl inside a drum to gain access to boiler tubes, the convenience of having tubes where you can get at them easily is a feature that meets users' enthusiastic approval. It also has other advantages—you don't have a long wait for the setting to cool when you want to look at a Springfield tube. Tubes can be inspected, or even replaced, and the boiler put back on the line in less time than it ordinarily takes to cool down the drums of a bent tube boiler. Springfield's 4-tube grouping reduces the number of hand holes two-thirds, or more, as compared with common straight tube designs. Larger hand hole opening is a real convenience in inspecting or rolling in tubes.

3 ELECTRIC FURNACE CAST STEEL HEADERS. Cast steel, the material selected for turrets and hulls of newest Army tanks, has long been used by Springfield to produce *better* headers for boilers and water walls. Backed by thirty years experience, Springfield headers are cast of high tensile strength electric furnace carbon or alloy steel, depending on the pressure, and are fully annealed. This construction provides a ductile but tough material exceptionally well suited for tight rolled joints and presents no seams or crevices to start corrosion or embrittlement.

4 WATER COOLED, REFRACTORY FILLED BAFFLES. Metal sleeve conductors between the cast baffle sections and the water tubes keeps baffles from overheating: Use of refractory filling reduces contact with hot gases. Springfield baffles fit tight, have no horizontal seams, and remain in proper position. Tubes can be easily removed without disturbing baffles which are customarily good for the life of the boiler.

5 SHOP ASSEMBLED SECTIONS. Tube sections are made up in the Springfield shop complete with front and rear headers, baffle sections, etc. Each section is hydrostatically shop tested and inspected at pressure at least 50% over working pressure and never less than 500 lbs. Springfield's distinctive 4-tube grouping arrangement, combined with the sinuous headers gives each section rigidity and strength to withstand handling in shipping and in the field. Valuable time and labor savings, particularly on shipments going into overseas locations.

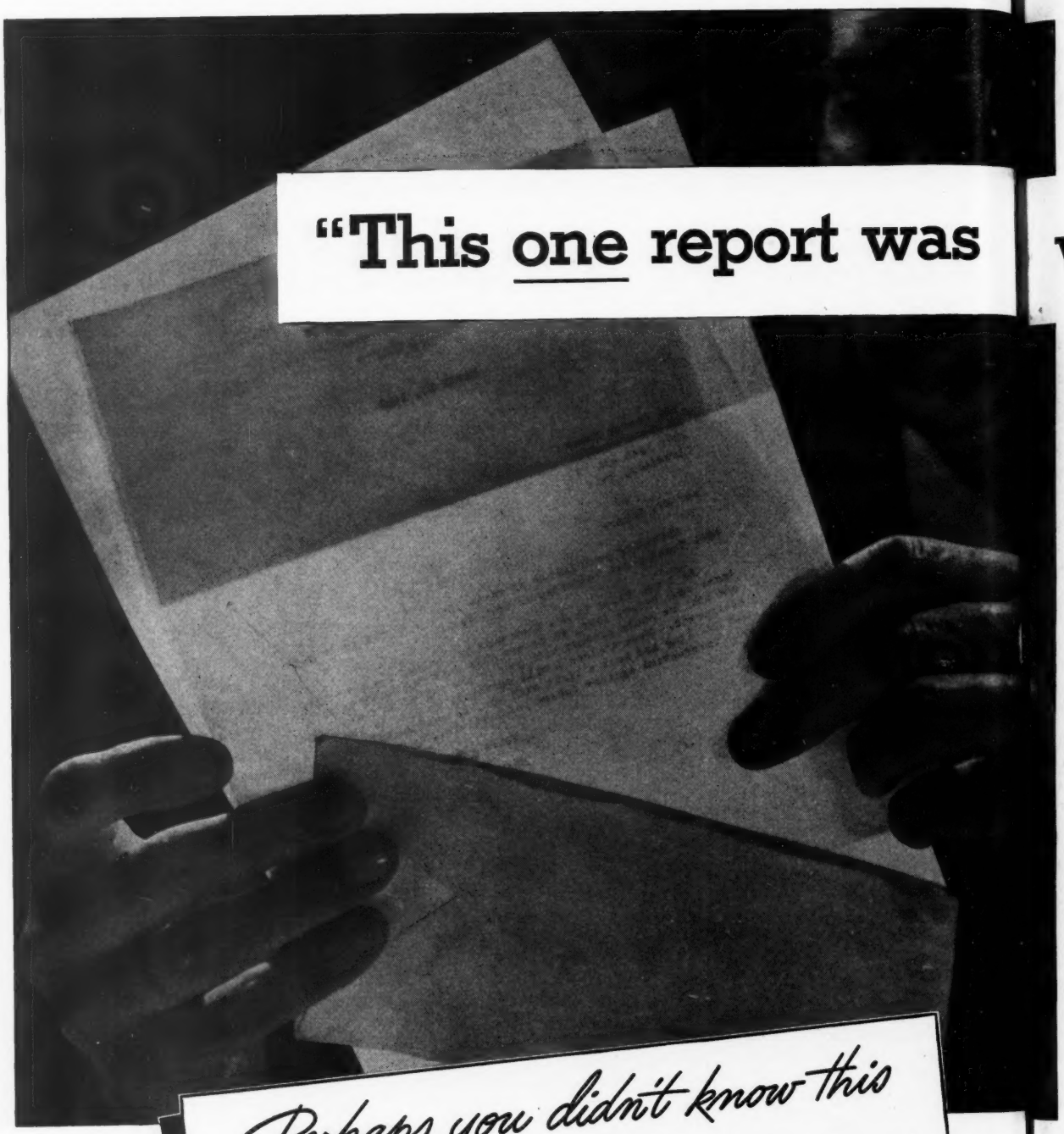
6 DRUM NOT EXPOSED TO HIGH TEMPERATURE. This is an important safety feature. Springfield's sectionalized construction makes it impossible for a large rupture to occur in the high temperature zone of the furnace.

7 CLOSE SPACING WATER WALLS. Designed to permit high output with a compact unit, Springfield's water wall construction also reduces temperatures on furnace brickwork to a point where maintenance is negligible. Close spacing minimizes possibility of extreme slagging and gives greater protection against high local heating with the result that Springfield water walls are less affected by bad water conditions.

DELIVERY. Organizations engaged in war work, or otherwise able to obtain priority ratings, can get quicker delivery—save money—and aid in conserving metals on steam plant requirements by taking advantage of the distinctive construction features of Springfield straight tube, cross drum, sectional header boilers. Complete drawings, patterns, shop fixtures, etc., are on hand to duplicate any of the many modern Springfield steam generating units built in recent years. Capacities from 5000 lbs. to 450,000 lbs. per hour, or more. Pressures from 75 lbs. to 750 lbs., or higher. Springfield regularly takes contracts for complete steam generating units. Write, phone, or wire for quotations. SPRINGFIELD BOILER CO., 1951 E. Capitol Ave., Springfield, Illinois.

BOILER CO.

ANY SIZE • ANY FUEL • ANY PRESS



Perhaps you didn't know this about Hall Service:

You can't be a Hall client and get into trouble you are unable to account for without its becoming our immediate concern. Such difficulties usually require a scientific interpretation. That's where Hall's complete service fits in. We spare neither cost nor time to see your plant through its difficulty.

If anyone ever tells you this elaborate background of skilled technicians and laboratory set-up is unnecessary in water conditioning service, ask him why the finest steam plants on land and sea, staffed with the most competent operators obtainable, use Hall Service year after year —would not think of doing without it.

worth the cost of Hall Service to us for 15 years!"

—PLANT SUPERINTENDENT FOR AN IMPORTANT CENTRAL STATION

HERE is one of many instances which illustrate what makes Hall Service supremely different from any other.

The scene is laid in the central power station of a network serving vital war industries—a Hall client since 1927.

Tube burnouts in certain new high-pressure boilers were causing serious interruptions to service. The operators had no way of accurately determining the cause. They suspected improper circulation. But, if this was the case, what would account for the peculiar deposit found on the walls of the burned out tubes? Would that indicate improper water conditioning? An answer had to be found or the trouble was bound to continue.

So they did what any good Hall client does. They turned the problem over to the service. A sample of the deposit was sent to the laboratory.

A quick, partial analysis showed definitely that the deposit was of unusual composition. Further, intensive examination and rechecking were clearly indicated. This work was done.

What followed is typical Hall procedure. The director of the service, together with technicians, went into a round-table huddle. Before them were the laboratory reports, the operating history of the plant, the field engineer's report on the history of the tube failures. The whole situation was explored.

The interpretation which followed was as clear as crystal. Without any doubt it established the fact that the tube failures were *not* the result of the deposit found, but rather that the deposit was the result of overheating of the tube metal due to insufficient circulation of the boiler water. This was framed in a report which clearly gave the answer the plant superintendent needed. He now knew exactly what to do to correct his trouble.

And that was what induced the superintendent to say to our Hall representative, "This *one* report was worth the cost of Hall Service to us for 15 years."

HALL LABORATORIES, INC.
HAGAN BUILDING PITTSBURGH, PA.

HALL SYSTEM
of Boiler Water Conditioning

Why I Selected *Bailey* Control

★ You asked me why I bought Bailey Meter Control instead of one of the other systems which also maintain steam pressure, regulate furnace draft and distribute load among boilers.

I bought Bailey Meter Control because it offers these plus values:—

1. An automatic readjustment of the fuel—air ratio which functions continuously to insure economical combustion at safe furnace temperatures day after day. Fuel is measured on a Btu basis.
2. It has been rightly said that a control system is no better than its metering devices—in the Bailey system control impulses are originated by standard Bailey Meters. In addition to insuring accuracy and sensitivity this arrangement saves the expense of secondary metering devices and duplicated connecting piping.
3. The Bailey system is engineered to protect my steam generating equipment against dangerous conditions. It can be provided with purge interlocks, fan failure interlocks, furnace draft or pressure interlocks, flame detectors, and best of all, it insures full automatic operation during times of emergency when operators may be desperately needed outside the boiler room.
4. The experience gained from making successful combustion control installations on over 1000 boilers during the past five years is built into my Bailey system.
5. I like the way the Bailey Control Drive Stands and linkage improve the appearance of my installation and at the same time provide for emergency manual operation.
6. When I want service I just turn to the local Representative (a full time Bailey man), who is a specially trained and thoroughly competent engineer well versed in the problems of combustion and boiler operation. I understand that Bailey Engineers are stationed in some thirty conveniently located cities throughout the United States and Canada.

These plus values mean a lot to me because it is my job to furnish a steady supply of power and process steam under uniform pressure and temperature conditions and at the lowest cost consistent with reliable service.

You too can get the full story on this complete combustion control system by asking for Bulletin 102-C.

Write to—

A-68-1

BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada

BAILEY METERS

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

FACTS YOU NEVER KNEW [BEFORE] ABOUT WATER-COOLED STOKERS

One User Tells Another User-to-be

"In answer to your inquiry, I cannot speak too highly of our Taylor Water-Cooled Stoker. Coals that we found undesirable on the old air-cooled stokers were found to give excellent and highly pleasing economic results when used on the Taylor Water-Cooled Stoker. Our unit has been in operation for just two years... We have never had an emergency shut down of the unit, to this date. We have not made a single parts replacement on the stoker and from all appearances, barring accidents, there will not be any for a long time. In all, the equipment has done much more than we expected of it; surely it is more than just another stoker."

PROPOSITION

A large Ohio plant faced the problem of selecting firing equipment which would combine, among other important factors, reliability, fuel flexibility, and efficient generation over a wide steaming range —burning the Ohio coals economically available.

PURCHASE

After a careful investigation of many types of firing equipment, the underfeed principle combined with water cooling demonstrated proven results under similar and actual operating conditions which showed promise of exceptional performance.

This plant, therefore, decided to install a Taylor Water-Cooled Stoker, capable of generating a maximum of 150,000 lbs. of steam per hour at 200 lbs. pressure. Total steam temperature: 525°F. The pressure parts were designed for future operation at 450 lbs., 750°F. total temperature. Other specifications called for a 1410 H.P. bent tube boiler, economizer, air pre-heater and completely water-cooled furnace.

PERFORMANCE

Period	Sept. 27, 1939 to Sept. 17, 1941
Unit in actual service, of total time	93.8%
Water evaporated	1,231,512,448 lbs.
Coal burned	125,201,845 lbs. (62,601 tons)
Actual evaporation	9.84 lbs.
Average steam pressure	180 lbs.
Average steam temperature	525°F.
Average temp. feed water to economizer	213°F.
Heat added to 1 pound steam	1,100.7 B.T.U.
Average heat value of coal	12,424 B.T.U.
Average overall operating efficiency	87.1%
Average steaming rate per hour	74,100 lbs.
Material cost for stoker maintenance	$183.00
Material cost per ton of coal burned	$.0029

CALLING ALL COALS . . . a geographical picture of the relation of typical Taylor Water-Cooled Stoker installations with respect to major coal areas of the nation.

3 Ways Better—or more

There are a dozen ways in which Taylor Water-Cooled Stokers can improve operation. Of them these three are outstanding: 1. By increasing reliability, 2. By increasing fuel flexibility, 3. By increasing operating efficiency. All the advantages, and the construction and installations of Taylor Water-Cooled Stokers, are presented in a new booklet which the coupon invites you to send for.

A-E-CO TAYLOR WATER-COOLED STOKER

AMERICAN ENGINEERING COMPANY
2408 Aramingo Avenue, Philadelphia, Pa.

Please send me your Catalog W on Taylor Water-Cooled Stokers, without obligation.

*Name*_____
*Company*_____
*Address*_____
*City*_____ *State*_____

REPUBLIC METERS ARE Bloodhounds

FOR TRACKING DOWN POWER LOSSES THAT HAMPER PRODUCTION

★

TO meet your increased steam demand, you are stretching the capacity of your boilers through shrewd operation. Great! But how much are you gaining if the rest of your plant wastes the steam? Instruments are the bloodhounds that track down these losses.

If you are faced with a steam shortage, a simple Republic metering system will provide data that will enable you to immediately locate and correct faulty or wasteful operating conditions. Elimination of these losses will at once increase your effective power plant capacity.

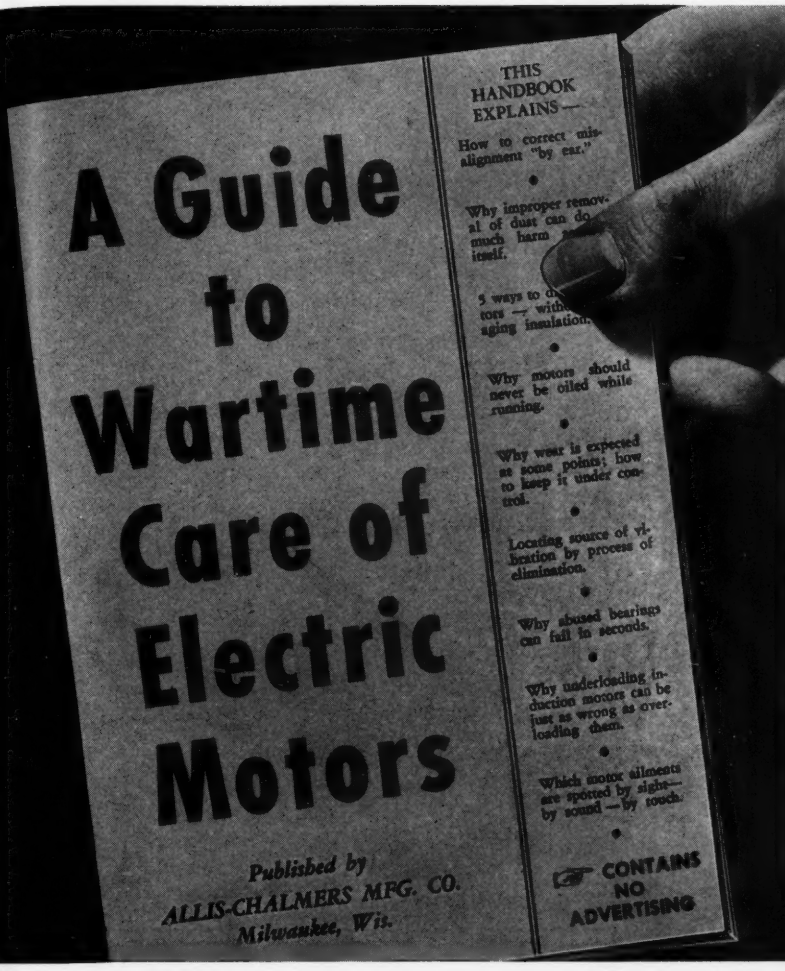
The engineering of such a system is a definite part of Republic service, rendered by engineers with wide experience in solving industrial metering problems. This engineering service—featuring the highly developed line of Republic flow meters—accounts for the outstanding success of Republic metering systems in hundreds of industrial plants.

This service is made available to you by merely asking to have a Republic engineer call at your plant. Your request will involve no obligation on your part.

REPUBLIC FLOW METERS CO.
2224 Diversey Parkway, Chicago, Illinois

Announcing

A VITAL NEW AID TO VICTORY PRODUCTION . . .


A Guide to Wartime Care of Electric Motors
THIS HANDBOOK EXPLAINS—
How to correct misalignment "by ear."
Why improper removal of dust can do much harm
Why motors should never be oiled while running.
Why wear is expected at some points; how to keep it under control.
Locating source of vibration by process of elimination.
Why abused bearings can fail in seconds.
Why underloading induction motors can be just as wrong as overloading them.
Which motor ailments are spotted by sight—by sound—by touch.
CONTAINS NO ADVERTISING
Published by ALLIS-CHALMERS MFG. CO. Milwaukee, Wis.

Your Copy is Free!

ENGINEERS — production managers — maintenance men — executives . . . here's a valuable new handbook that you're sure to want for your technical library . . . a book designed to help you meet today's *new* motor maintenance problems!

And they *are* new problems . . .

Wartime's three-shift production has crowded *triple-duty* for motors into every day. New working days have been added!

All told, a motor's working time has skyrocketed since the emergency from 1800 hours a year to *8700 hours!*

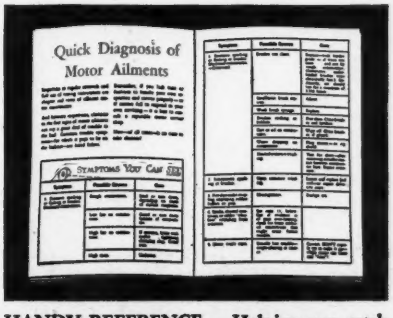
That means that inspection, adjustment, lubrication check-ups — all must be quadrupled . . . and must be geared up to wartime standards of efficiency!

To help you most, "A Guide to Wartime Care of Electric Motors" applies to *all* makes of standard, general-purpose motors. And it takes a *fresh* look at motor care.

For Allis-Chalmers recognizes — as you do — that maintenance "as usual" went out with Pearl Harbor.

Send for this Valuable new Handbook today

COMPLETELY ILLUSTRATED — Making principles of motor care crystal clear. Of particular value for training new men.



HANDY REFERENCE — Helping you catch motor troubles at early stage. Tear out order form and send for *your* free copy!

ALLIS-CHALMERS MFG. CO.
Milwaukee, Wisconsin

Gentlemen:

Yes, I would like to receive *free of charge* "A Guide to Wartime Care of Electric Motors".

(Name) _____

(Title) _____

(Company) _____

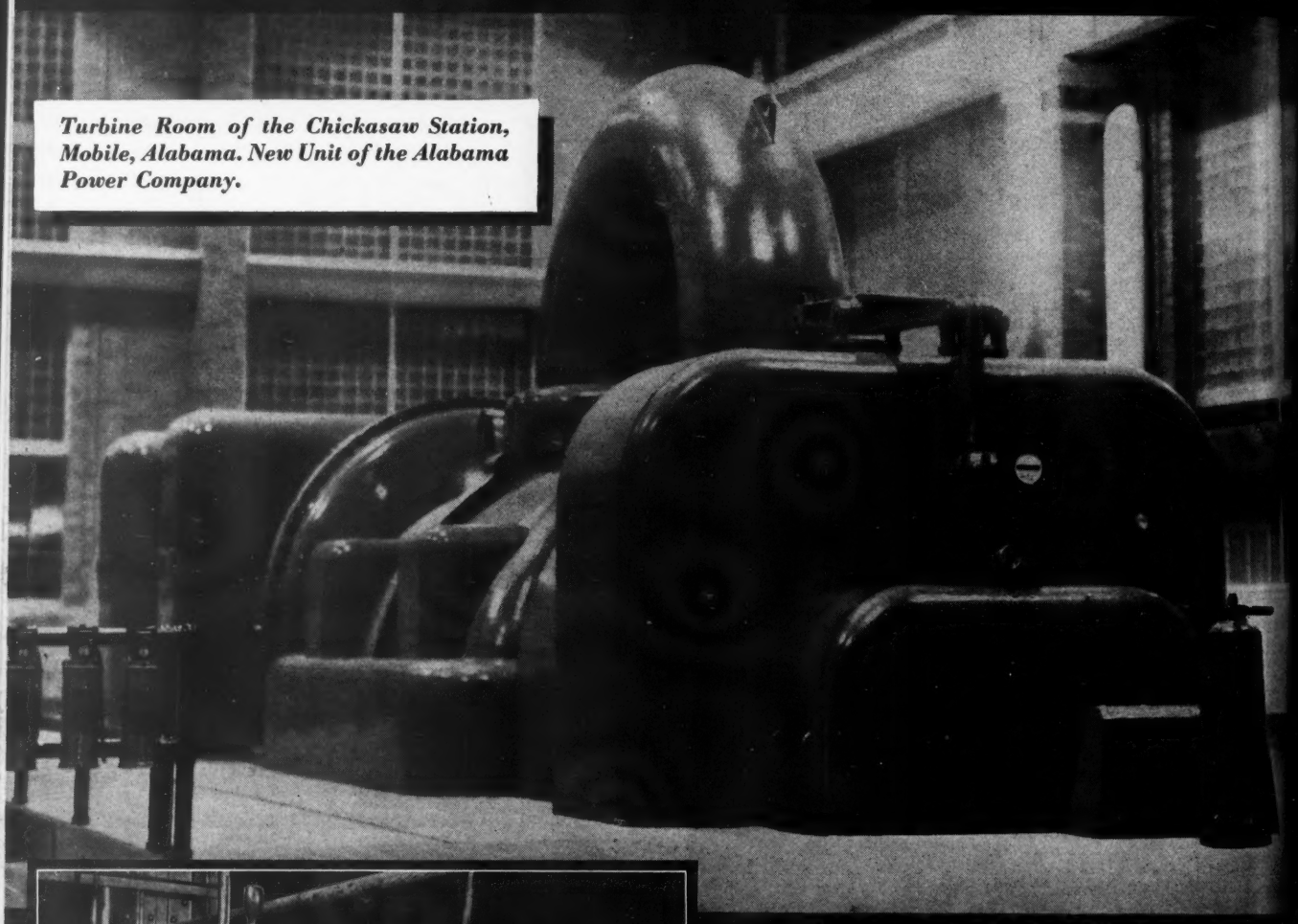
(Street Address) _____

(City and State) _____ A 1533-10

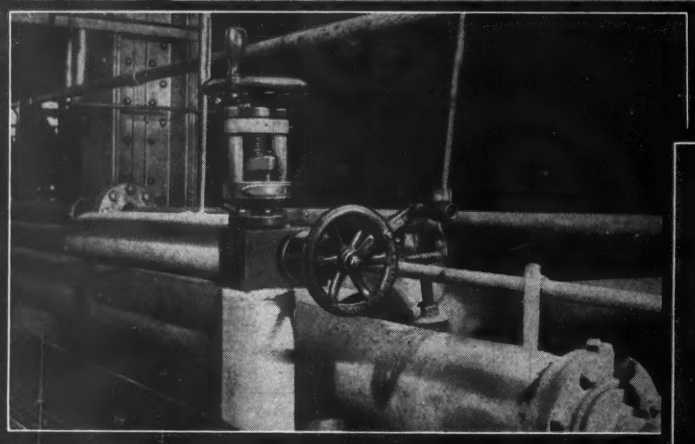
ALLIS-CHALMERS
MILWAUKEE · WISCONSIN

WE WORK FOR VICTORY WE PLAN FOR PEACE

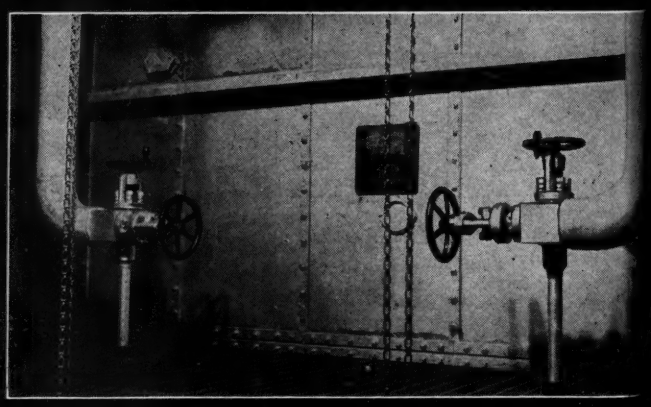
YARWAY at



Turbine Room of the Chickasaw Station, Mobile, Alabama. New Unit of the Alabama Power Company.



Main Boiler Blow-down lines at Chickasaw Station equipped with Yarway Unit-Tandems.



Yarway Unit-Tandem Blow-Off Valves on water-wall Drains at Chickasaw.

YARWAY

Chickasaw, Ala.

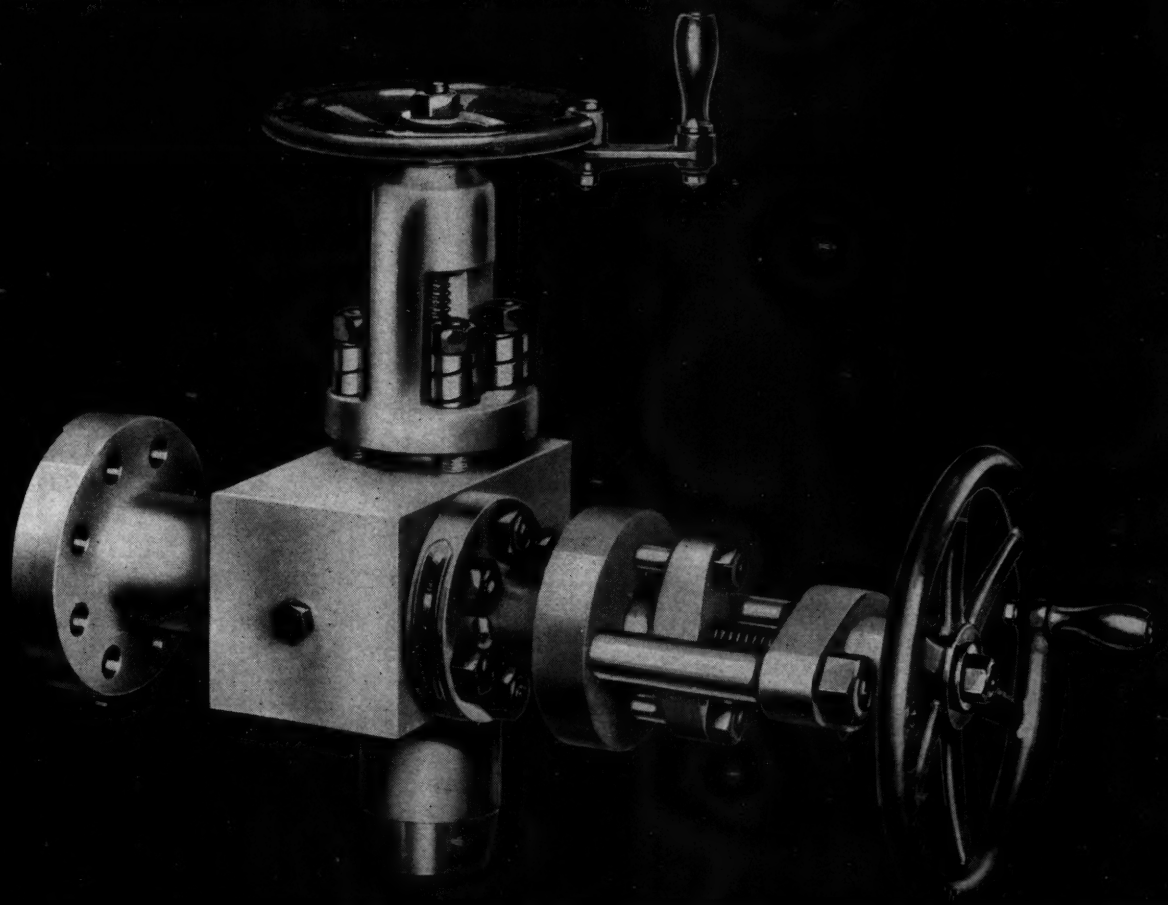
900 lbs per sq. in., 900°—Chickasaw Station, Alabama, is 100% equipped with Yarway Unit-Tandems on all water-wall drains and boilers now in service.

Years of service in the highest pressure plants of leading utilities and industrials have proven the sound design and metallurgy of the Yarway Unit-Tandem for blowing-down or draining and sealing.

Such records as—"3000 blows at more than 1300 lbs per sq. in. pressure, without a single replacement of parts or repairs of any nature"—have made this Tandem the outstanding preference for high pressure service, today.

What are your draining and blow-down valve requirements? Write for Catalog B-431 for pressures up to 2500 lbs Catalog B-421 for lower pressures.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia



BLOW-OFF VALVES

THE COST OF A LOST MINUTE . . .

Each minute lost while machines stand idle may cost hundreds of lives and delay the winning of the war.

GARLOCK is doing its part for Victory by producing dependable, long-lasting packings and gaskets which help industry avoid frequent shutdowns for repacking and for replacement of gaskets.

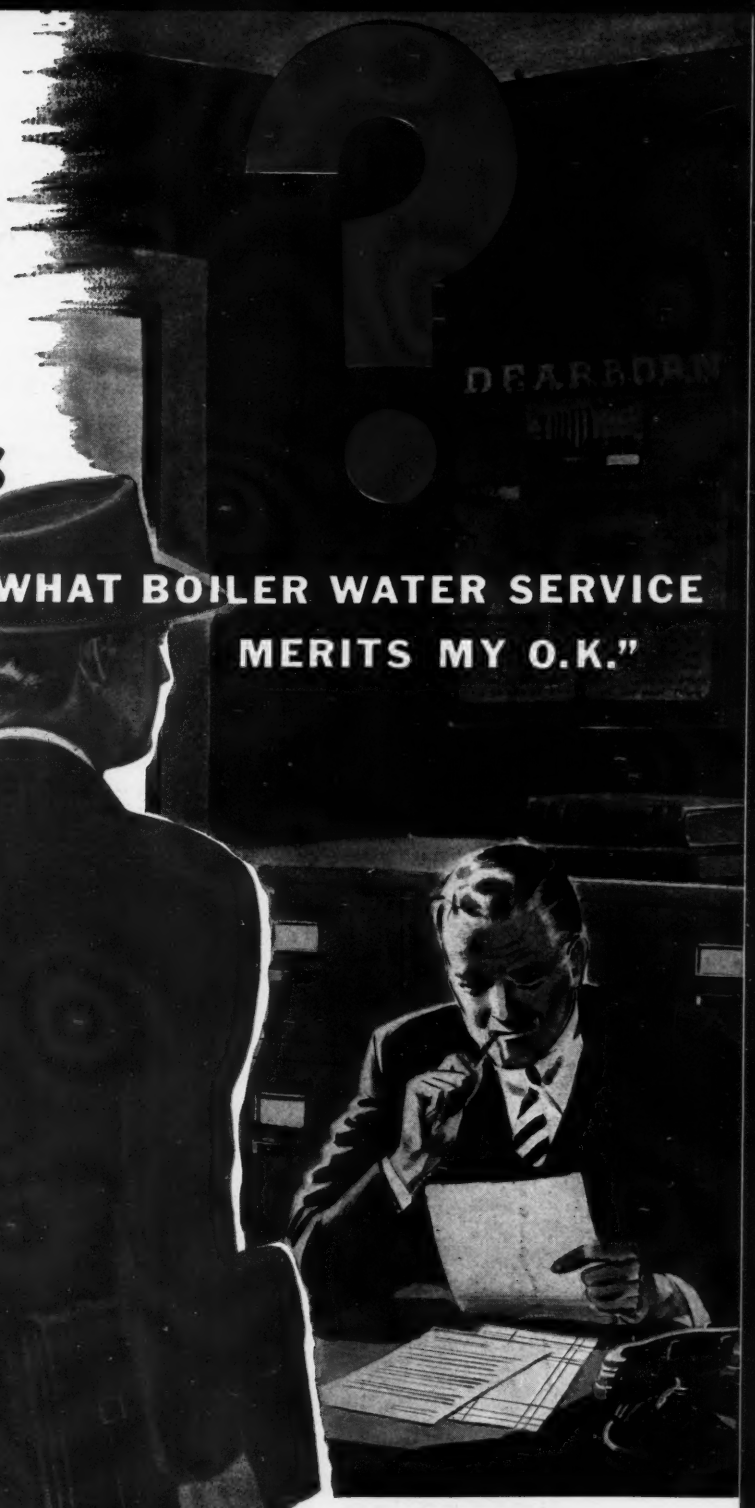
GARLOCK

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd.
Montreal, Quebec

DEARBORN ENGINEER HAS

the answer to the Chief's Question..



Doping the water is not the answer. Installing equipment for feeding chemical treatment, while important, is not the answer either. Boiler water treatment service has to be much more individual and scientific than that.

Dearborn Engineer recognizes that from the very start. But his accumulated experience enables him to come up quickly with the correct answer to your problem. He knows local water characteristics, too, because he has worked and lived in his district a long time. He studies the operating conditions of your plant, recommends correct treatment, and then keeps in contact with you periodically to see that full efficiency is maintained.

Power plant engineers lean heavily on that kind of scientific service . . . a thoroughly grounded 6-point service. Over 8000 power plants use it. Acquaintance with the Dearborn Engineer will reveal a service which fully merits *your* O.K. Drop us a line . . . we'll arrange for him to see you.

DEARBORN CHEMICAL COMPANY
Dept. D, 310 S. Michigan Avenue, Chicago, Illinois

Dearborn Engineer does this for you . . .

(1) *Studies* your water and plant operating conditions.
(2) *Sends* samples of your water to main laboratory for analysis.
(3) *Recommends* proper chemical treatment and chemical control methods.
(4) *Supervises* installation of feeding equipment.
(5) *Instructs* your men on water test methods for treatment dosage adjustment and blow-down control.
(6) *Calls* regularly to insure maintenance of recommended conditions.

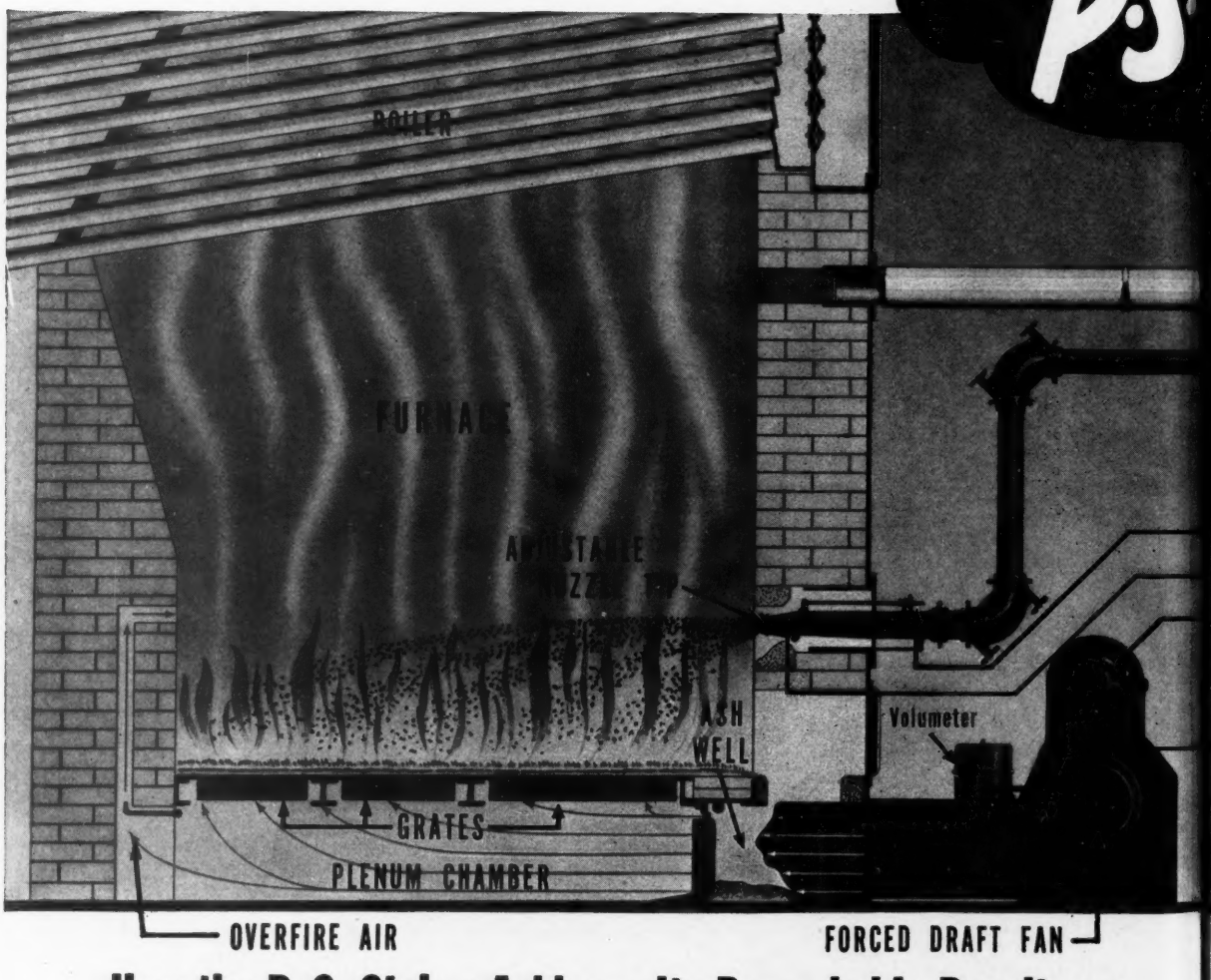
Dearborn

WATER TREATMENT AND ENGINEERING SERVICE

Fastest Growing Type of Fi

AMERICA'S power plant engineers immediately recognized, when it was announced nearly a decade ago, the important engineering advance embodied in the Pneumatic Spreader principle. Year after year, Iron Fireman Pneumatic Spreader stoker firing has been the fastest growing type of firing in U. S. industry. Today, Iron Fireman Pneumatic Spreaders are making an important contribution to the war effort by stepping up steam output of typical boiler plants *10% to 35%*, and at the

IRON F
P·S·S



How the P. S. Stoker Achieves Its Remarkable Results

AS shown in the illustration above, the Iron Fireman Pneumatic Spreader conveys steam size coal from the hopper or main coal bunker to a transfer housing, where the coal is picked up by a stream of air and conveyed to the furnace and grates. The fines burn in suspension, utilizing the conveying air for combustion. The larger pieces form a shallow fuel bed on the grate. By means of an adjustable nozzle, the coal is dropped by gravity and *distributed uniformly over the entire surface of the grates.*

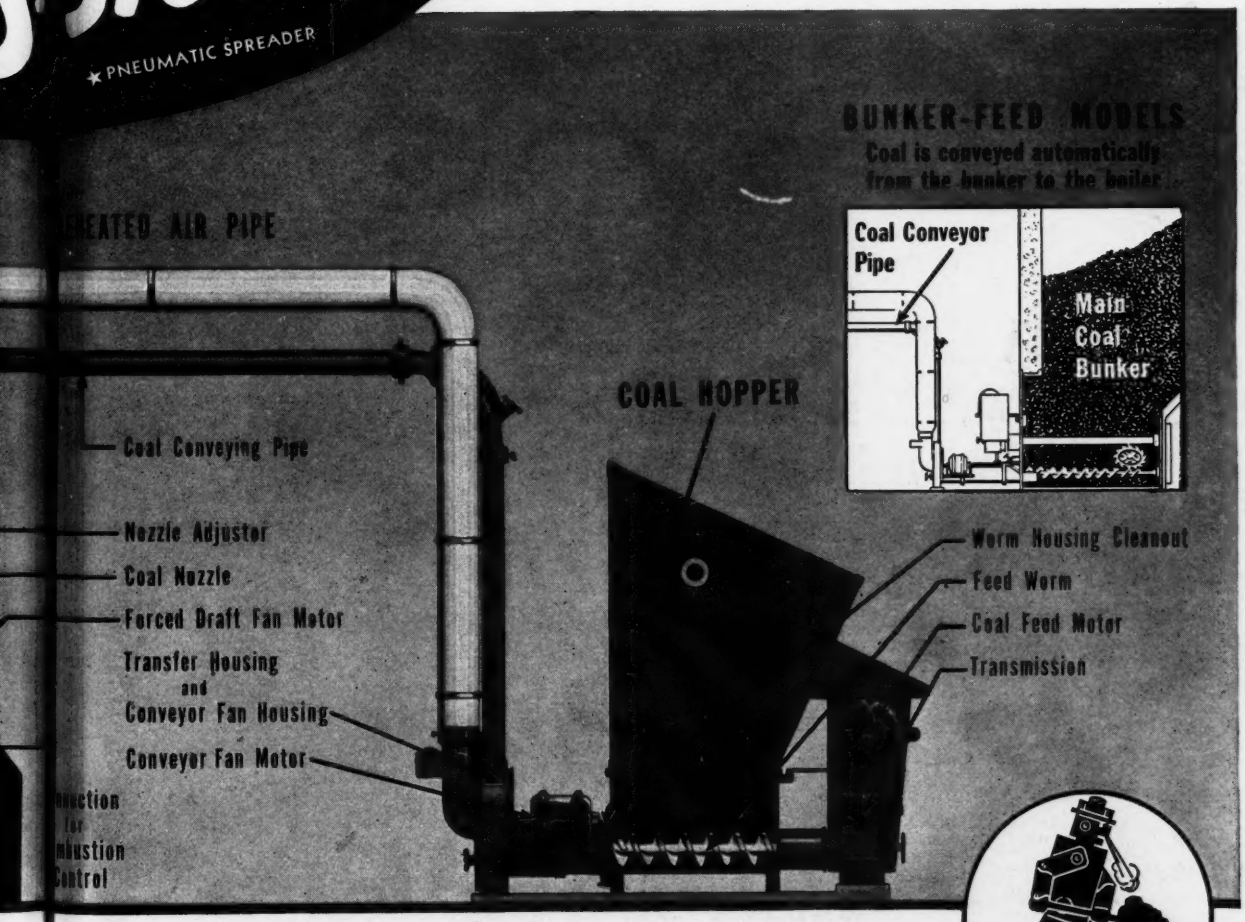
The conveying air provides the overfire air which is, of course, a requisite of efficient combustion. This air is more intimately mixed with the coal than is possible by any other means. Entering at right angles to the flow of undergrate air through the fuel bed, the conveying air produces *maximum turbulence; another requisite of efficient and smokeless combustion.*

...of Firing in U.S. Industry

...N FIREMAN ...S. STOKER

★ PNEUMATIC SPREADER

same time cutting fuel costs. Automatic firing and coal handling gives boiler room employees more time for productive work. There are definite reasons for this wholehearted acceptance of a new firing principle in the boiler plants of many of America's greatest industries. You owe it to yourself to become fully posted on this significant development in the science of firing.

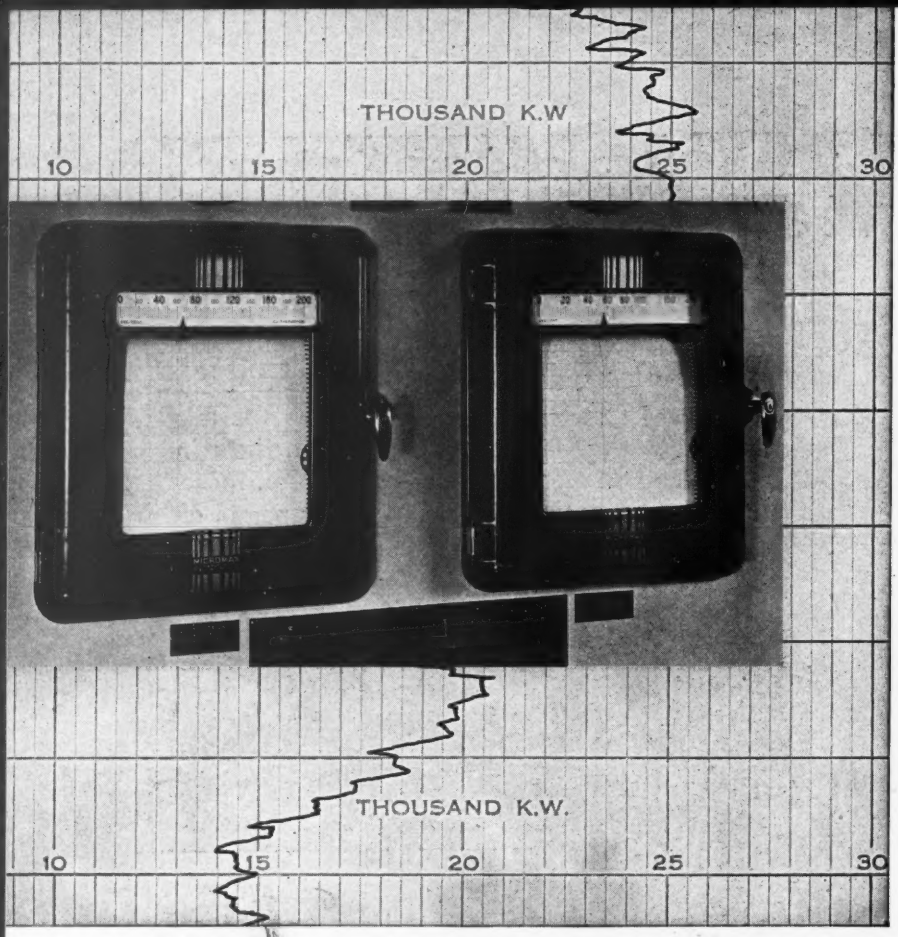


Applications are flexible; the stoker can be set at boiler room floor level, or on the floor above or below. It can be located at any angle in front of the boiler, and at distances of 30 feet or more from the boiler front.

The Iron Fireman Pneumatic Spreader stoker was designed to burn efficiently a wide range of such economical fuels as the lower grade bituminous coals and also sub-bituminous and lignite coals, and to provide *a reliability of operation, physical adaptability, ease of operation,* and *low maintenance* not afforded by other types of automatic coal burning systems.

FREE BOOK on Pneumatic Spreader Firing

Contains full descriptions, capacities, operating data, etc., with layouts and photos of 10 actual installations. Sent free, on request. Write to Iron Fireman Mfg. Co., 3317 West 106th Street, Cleveland, Ohio.



When load begins to rise, as shown by this Micromax load record, the temperature recorders shown in the insert help watch over generator temperatures. Multiple-point Micromax at left records stator temperatures; instrument at right records rotor temperature.

MICROMAX TEMPERATURE RECORDERS Will Help When Overload Piles Up

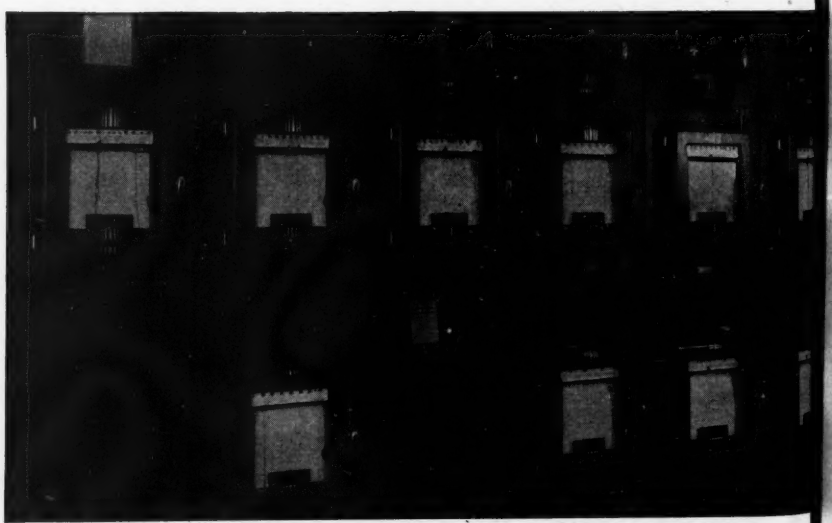
Several years ago, an east-coast power plant was confronted with the need for running at as much overload as it could carry, for a period of several days. Instead of loading their generators solely on the basis of wattmeter and ammeter readings, they used generator temperature, as shown by a Micromax recorder, as the limiting factor. By running right at the highest safe temperature, they got through the emergency safely.

Today, such emergencies are more frequent, for increased requirements of war industries are causing severe peak loads all over the country. And it is even more essential now to hold temperatures below dangerous values, in order not to endanger equipment that is both badly needed and difficult to replace. At the same time, it is often necessary to have machines carry the absolute maximum load without exceeding the permissible temperature.

In many power plants, Micromax temperature recorders are helping to protect equipment by giving operators the required temperature facts accurately and dependably. On the Micromax chart, the operator can watch the rate of heating or cooling, and by holding this rate at a low value, he can allow copper and insulation to expand or contract at the proper rate without excessive strain on the insulation.

Micromax instruments are frequently equipped with alarms or signal lights which summon the operator when the safe limit of temperature is exceeded. Rotor temperature recorders are single-point instruments. For recording other temperatures, however, multiple-point Micromax instruments can be used for as many as 16 temperatures.

If you'd like further details, we'll be glad to send, on request, Catalog N-33-161, *Micromax Temperature Instruments for Electric Power Equipment.*



On this control panel for a large hydro station are Micromax temperature recorders for fields and stators of three generators. Shown also are Micromax transformer temperature recorders, and instruments for load-frequency control.

Jrl. Ad N-33-161(2)

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES

Anytime
IN WAR OR PEACE—
you can depend on Morse Silent and Roller Chain Drives to provide capacity and stamina to keep maximum production rolling, free from costly maintenance or breakdowns.
Reliability and high efficiency in capacities from fractional to thousands of horsepower.
That is what all big production needs.
SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES
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WHAT HAPPENS in the BOILER?

SIRENS Scream Blackout—a dramatic drop in load—a routine workout for the COPES Flowmatic Boiler Feed Water Control. Independent of any other control in the plant, Flowmatic does its one job of maintaining a safe water level at all times—takes orders only from the boiler it serves.

Over 2,000,000 H. P. of boilers in central stations, steel mills, paper mills, forge shops, refineries, chemical plants, and the like, are protected by COPES Flowmatic against water level hazards which might come from violent load changes.

Flowmatic, the two-element steam-flow type feed water regulator, keeps boiler water at the safe level, no matter what the range of steam demands. Steam-flow and water-level curves prove this fact. Bulletin 429 reproduces typical charts and illustrates installations. Write for a copy.

NORTHERN EQUIPMENT COMPANY, 722 GROVE DRIVE, ERIE, PENNA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

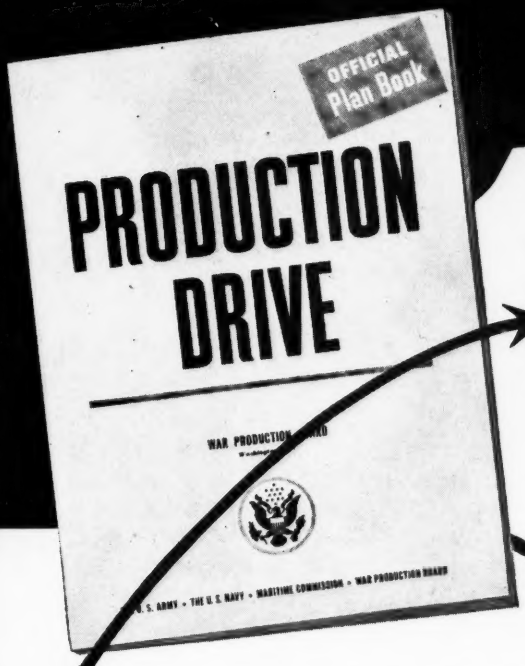
BRANCH PLANTS IN CANADA · ENGLAND

REPRESENTATIVES EVERYWHERE

COPES FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

★ GET CLOSER LEVEL CONTROL WITH THE FLOWMATIC ★ REGULATOR

WAR PRODUCTION DRIVE HIGHLIGHTS PROPER LUBRICATION



The plant Production Drive Committee, therefore, should give close attention to such problems as:

1. Taking care of tools.
2. Preventing breakdowns.
3. Cutting down accidents.
4. Good lighting.
5. Maintenance and repair.
6. Adapting old machines to new uses.
7. Cutting wastage.
8. Breaking production bottlenecks.
9. Using every machine to the fullest extent.

Five of the nine suggestions for "Increasing Plant Efficiency" in WPB's PRODUCTION DRIVE include problems in which Standard Lubrication Engineers can give you valuable help. For instance:

2 PREVENTING BREAKDOWNS

● NEW OPERATORS . . . new types of equipment . . . new highs in production . . . any one of these opens the door to increased equipment failures in your plant. These safeguards are more than ever important:

- Examine every motor, reduction gear, or bearing-equipped machine that now carries a heavier load—for adequate lubrication, for leakage, overheating, and oil contamination.
- Revise lubrication schedules to meet the longer hours of operation, higher speeds, and heavier loads.
- Choose lubricants that do the job best, regardless of cost. Today, breakdowns cost lives as well as dollars.
- Impress new operators or maintenance men at the start with the importance of lubrication at proper intervals.

The drive for production is urgent. Your time is limited. Let a Standard Lubrication Engineer work with those in charge of your maintenance. Take advantage of his recent experience in problems just like yours.

Write Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago, Illinois, for the Engineer nearest you.

OIL IS AMMUNITION — USE IT WISELY

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STANDARD OIL COMPANY (INDIANA)

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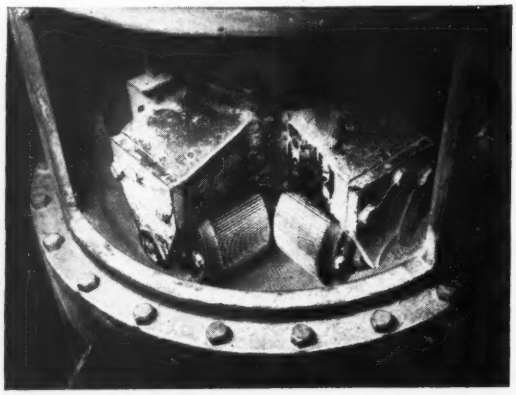
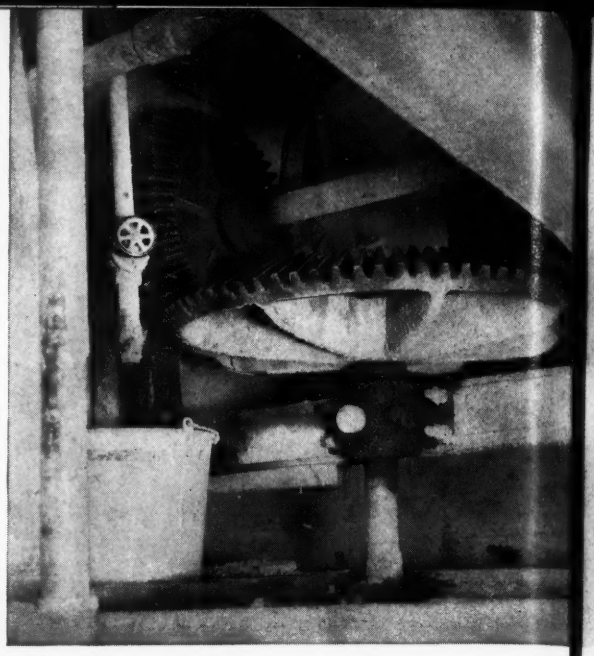
LONG LIFE FROM MILL BEARINGS WITH SUPERLA GREASE

Alvin Enerson, pictured below, is giving you the benefit of a lot of experience, when he says, "Superla Grease has given the results we have been looking for."

His company, the Stockdale Fertilizer Co., Morrison, Illinois, was anxious to realize the long life the manufacturer had built into this excellent equipment. After trying a number of greases, Mr. Enerson found the most satisfactory was Superla Grease, particularly designed for



high grade anti-friction bearing lubrication. Let a Standard Oil Engineer see if he can help you save bearing replacements and maintenance time with the right grade of Superla Grease.



ONE-THIRD AS MUCH GREASE —30% LESS MAINTENANCE— ON OPEN GEARS WITH CALUMET VISCOUS LUBRICANT

Lubrication of open gears in a Minnesota clay preparation plant offered a complicated problem. Conditions varied from exceedingly dry and dusty to very humid. Temperatures ranged from 65° to 100°. Lighter greases were thrown off the gears and contaminated the product, causing excessive waste. Heavier greases did not protect the gears against wear under the dusty conditions. No grease seemed to fit the job, and many were tried.

Then a test was made of Calumet Viscous Lubricant. Here's what B. B. Evans, plant superintendent at the Red Wing Potteries, Inc., reports:

> "We have tested Calumet Viscous Lubricant No. 10X and are now using it on all open gears throughout the plant. We have found this product to be superior to any other used."

Here are some of the savings he made:

- One-third as much grease used—and one-third as many man-hours for lubricating.
- 30% less maintenance—a saving in scarce materials and man power.

If you have a problem of open gear lubrication, ask a Standard Lubrication Engineer to help you make a similar test.

Just write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois, for the engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

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EVAPORATORS EJECTORS

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LUMMUS

As a leading designer and builder of complete refineries, Lummus was for years the largest single purchaser of heat transfer equipment. In a 40,000 barrel per day refinery, for example, heat exchangers, lube oil coolers, etc., will amount to more than half a million dollars.

With a view to securing heat exchangers and similar equipment of improved design, made to even higher standards of precision and workmanship, Lummus decided to make — and for four years has been producing — heat exchange equipment for the plants it designed and built.

Recent expansion of the Lummus heat exchanger plant at Honesdale, Pennsylvania, makes available a limited capacity for surface condensers, feed water heaters, evaporators, ejectors and similar equipment for the public utility and power fields. In addition to improved design and new standards of precision, public utilities and power plants are offered the services of Lummus engineering personnel for the study of specific problems and the design and construction of Lummus-built equipment to meet definite conditions. Requests for further information will receive prompt attention.

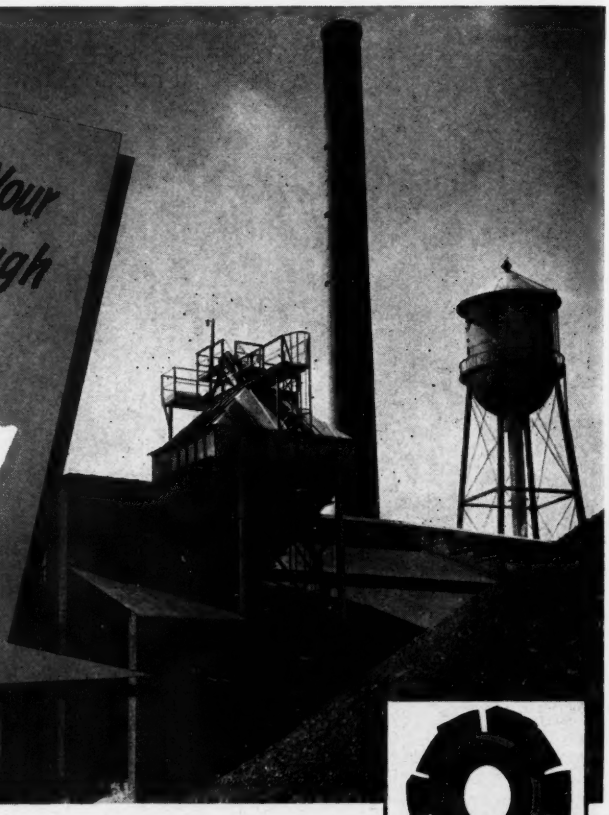
THE LUMMUS COMPANY • 420 LEXINGTON AVE., NEW YORK, N. Y.

LUMMUS

More POWER From Your Present Boilers Through

Better Sizing

the "AMERICAN" way..



Proper Preparation a "Must" in Today's Coal Conservation for Power Plants

THE Bemis Bros. Bag Co., Peoria, Ill., pictured above, is one of the growing list of industrial plants and central stations which use AMERICAN Ring Crushers to prepare coal for better sizing—and thus get improved combustion efficiencies and increased outputs from present boilers.

Your plant, too, can make your wartime coal piles last longer and do more work by preparing and sizing coal the economical "AMERICAN" Way. On the average, "AMERICANS" size coal for less than one cent a ton (for all charges) and reduce fuel bills from 2½ to 8%.

AMERICAN Ring Crushers, in one operation, reduce run-of-mine or lump coal to the proper sizes required for unit pulverizers and automatic stokers. They are of heavy steel construction for long life, are equipped with anti-friction bearings for low power consumption and can be counted on for high crushing capacity.

Shredder rings in "AMERICAN" Crusher splits coal and prevents bothersome clogging.

If you are concerned with getting the most from your wartime coal piles—investigate the "AMERICAN" Way. Send for a free copy of "Crushing Coal at Less Than One Cent A Ton." It contains helpful data on how to size coal properly for maximum boiler performance.

AMERICAN PULVERIZER COMPANY, 1429 MACKLIND AVENUE, ST. LOUIS, MO.

AMERICAN PULVERIZER COMPANY
1429 Macklind Ave., St. Louis, Mo.

Please send me, without obligation, a copy of your new Bulletin "Crushing Coal at Less Than One Cent A Ton."

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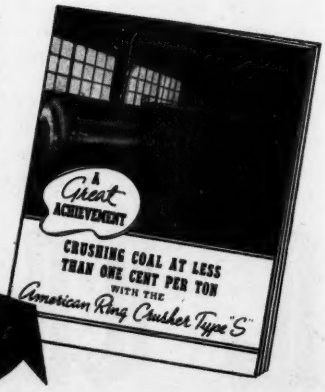
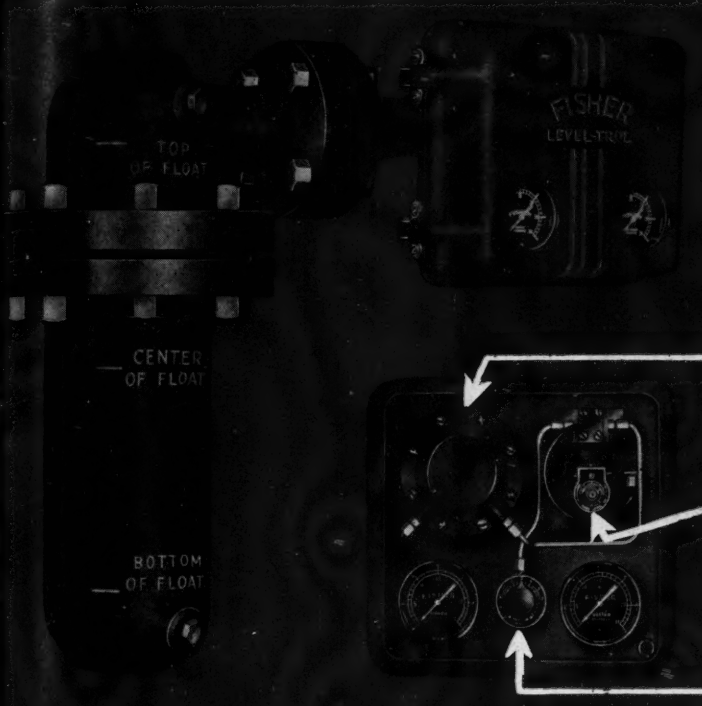


MAIL COUPON FOR *Free* DATA BOOK ON COAL SIZING

FISHER ANNOUNCES an Improved DISPLACEMENT TYPE LEVEL-TROL

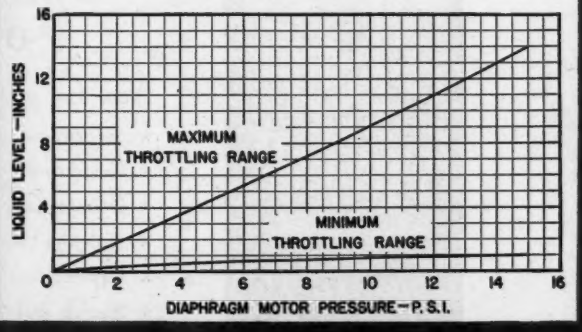


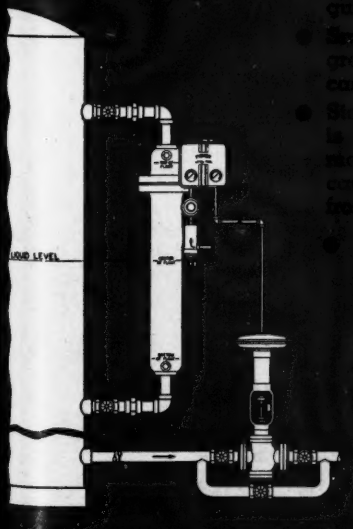
Pilot Relay Speeds Action of Diaphragm Valve in Response to Level Change. Intermittent bleed relay, greatly magnifies pressure and volume of air passing through primary orifice system. Response of diaphragm valve to level change is extremely rapid.

Level Position Adjustment Permits Operator to Control Level at Any Desired Point within Length of Float. Adjustment is easily made by turning the knob in accordance with the arrow on adjustment dial.

Throttling Range Adjustment Makes Level-Trol Suitable for Wide Variety of Applications. Makes it possible to vary amount of level change necessary to fully stroke diaphragm valve. Minimum level change may be as little as ½" and the maximum equal to length of float. Adjustment knob provided with calibrated dial — easily operated — readily accessible.

Straight Line Action . . Curves, below, illustrate how pressure changes on diaphragm as level changes throttling range setting in the two extreme positions.





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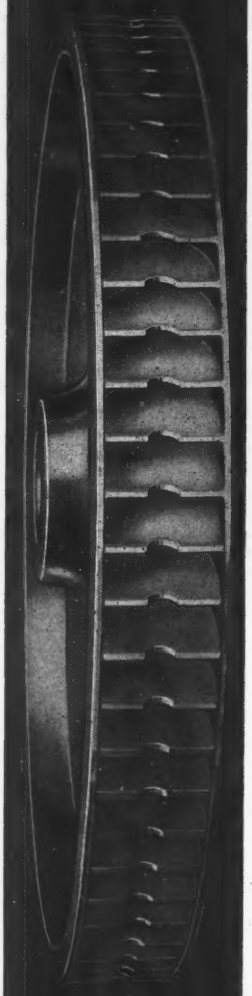
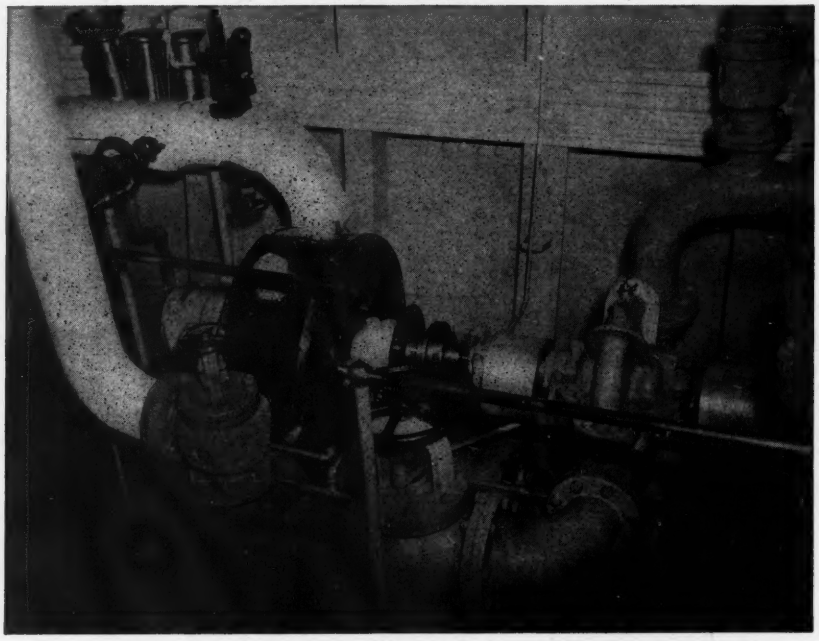




Above — 50 H. P. Terry Solid Wheel Turbine driving Fire and Sanitary Pump on recently completed merchant ship. Steam condition: 450 lbs. 750° TT. - 10 lbs.

FOR AUXILIARY DRIVE — THE TERRY SOLID WHEEL TURBINE OFFERS MANY ADVANTAGES

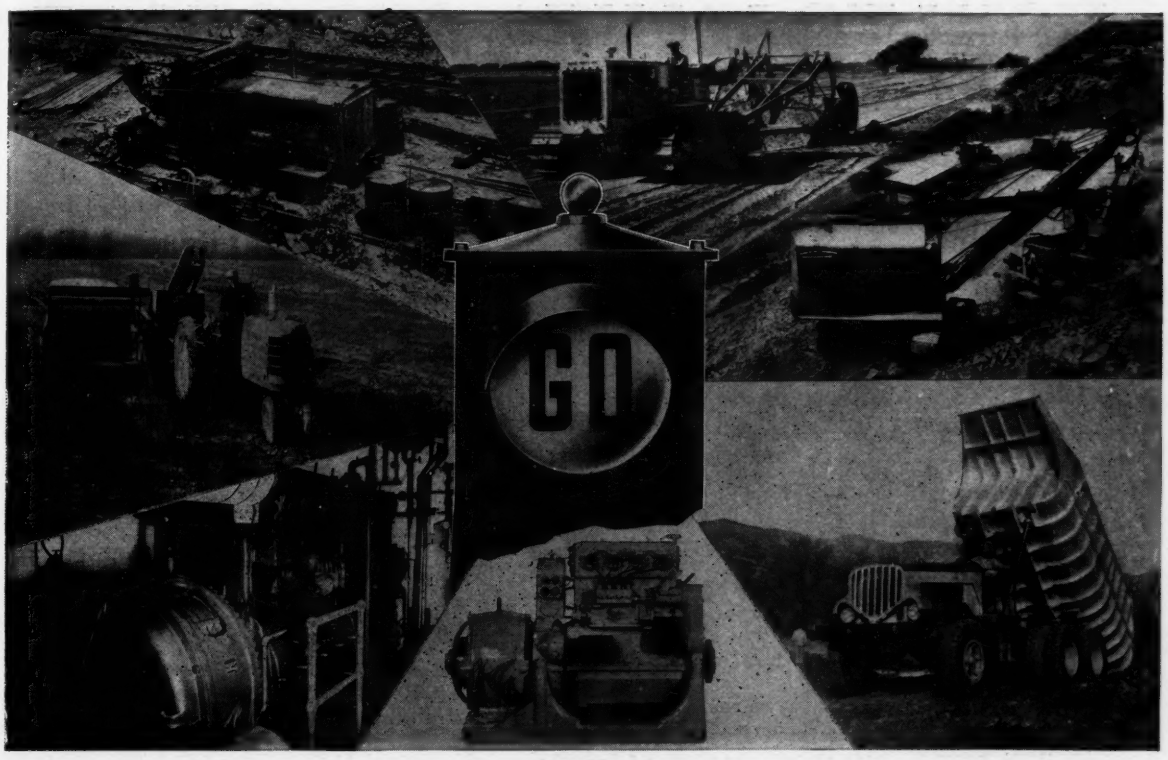
FROM THE SMALLEST TO THE LARGEST, THESE RELIABLE TURBINES HAVE —

- ★ Indestructible one piece wheel.
- ★ Large radial and axial clearances.
- ★ Double rim protected blading.
- ★ Individual nozzle control.
- ★ Dependable and durable governor.
- ★ Heavy dust-proof bearing and governor housing.
- ★ Independent overspeed trip with separate valve.
- ★ Sturdy casing design.
- ★ Stong and easily inspected steam strainer.
- ★ Truly accessible construction, which makes inspection of the interior parts a simple matter.

FOR FULL DETAILS ASK FOR BULLETIN S-116.

T-1148

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



Production Gets the Green Light— When Your Diesels Go Cities Service!

Steady operation for super-production — that's the order of the day for every Diesel engine owner! It means fewer stoppages, fewer overhauls. And parts must last longer—even though your engines are driving harder than ever.

Today, production is a race against time. An hour lost is victory delayed. A day's halt may spell disaster.

Your big problem then is how to go *all-out* for victory without *time-out* for repairs . . . how to achieve *steady, continuous performance without breakdown.*

You'll find a Cities Service lubrication engineer a great help in beating this problem. He understands what you're up against, and he speaks your language. And, most important, he's got the necessary "know-how" to tackle your particular job. So why not get together with him on a lubrication plan that will keep your Diesels in continuous service — with no time lost for costly repairs?

There is no charge for this friendly consultation. Simply fill in the coupon below and mail it today.

An informative, up-to-the-minute booklet, "Diesel Engine Lubrication," is yours for the asking. Just check the space indicated!

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Please send me information concerning your Engineers' Lubrication Service. ☐

Please send me your booklet, "Diesel Engine Lubrication." ☐

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P. P.

A LUBRICANT FOR EVERY INDUSTRIAL NEED

HOW TO MAKE YOUR STOKERS

. . with less outage and

If this information is not of immediate interest to you, please see that it reaches the proper man in your organization.

If yours is one of the many plants operating single-retort, underfeed stokers, here are some suggestions that will help you get longer life out of your present equipment and minimize outage for repairs or replacements. While they relate primarily to the three C-E underfeed stokers here illustrated, they are largely applicable to all single-retort, underfeed types.

OPERATION

GENERAL The two main causes of excessive outage and maintenance are (1) sustained or frequent overloading of stoker and (2) operating with insufficient draft.

Where prolonged overloading is unavoidable, as is often the case in these days, good operation and careful attention to maintenance are especially important. Frequently, in such cases, the use of a higher quality coal will make it possible to carry the increased load without excessive outage or maintenance costs.

Where difficulties are due to insufficient draft, the suggestions here under the heading "Draft" may prove helpful.

FIRE (1) Keep fire out of retort. This condition can result from too thin a fuel bed, from banking with insufficient fuel or from running with an empty hopper.

(2) Operate so that ends of grate bars adjacent to dump grates are always covered. Watch this condition after operating dump grates, and, if ends of bars are bare, speed up stoker until they are covered.

(3) Working of fire should be avoided as much as possible. If fuel bed requires leveling off, light rake or T-bar should be used on surface of fire. Never slice the fire as is done in hand firing by pushing a bar under the fire and raising it through the fuel bed.

(4) Be sure that fuel distributes uniformly over grate. Position of pusher blocks in retort can be adjusted to assure proper distribution.

(5) Be sure to feed sufficient fuel when banking. May be necessary to renew supply during long banking periods.

(6) In cleaning fire, do not remove ash and clinker that remain on grate bars after dumping. Allow them to move down on to cleaned dump grates by normal operation of stoker.

(7) Don't permit too much ash to accumulate in ash pit.

(8) When stoker is being shut down, sufficient ash should be fed in to keep fire out of retort.

(9) Depth of fuel bed is very important. If too thin, fire may burn down into retort and damage retort sides. If too heavy, poor air distribution will result, causing spotty, uneven fire; holes in fuel bed; smoke and reduced efficiency. Correct depth of fuel bed above top of retort may be anywhere from 4 in. to 8 in., depending upon analysis and burning characteristics of coal used.

DRAFT (1) Draft gage and a CO_2 indicator are essential to good operation.

(2) Operate with slight draft just above fuel bed – preferably 0.10 in; not less than 0.05 in. Plus pressure will cause excessive temperatures at grates and lower wall areas.

(3) Maintain proper supply of air at all times. Either too much air or too little air will reduce efficiency and capacity.

(4) Some air should be allowed to pass through grates at all times except when fire is banked.

(5) Don't force stoker beyond capacity of stack to carry away gases.

(6) Keep wind boxes properly sealed to prevent leakage of air into ash pit and furnace.

(7) If draft is insufficient, check leaks in setting and losses through boiler and flue connections; check position of boiler damper. Careful checking will usually disclose conditions that can be improved.

CLEANING (1) Remove siftings from wind boxes often enough to prevent any possibility of fire under grates. Frequency of cleaning depends upon type of fuel used, but wind boxes should be inspected once every shift.

(2) Keep front of stoker clean to prevent contamination of lubricants and excessive wear on moving parts.

INSPECTION & MAINTENANCE

(1) All accessible parts of the stoker should be inspected daily. Those parts which cannot be examined while the stoker is in service should be thoroughly inspected at least twice a year and more often if practicable.

(2) On daily inspections, look especially for loose bolts and loose connections in moving parts. Where movement is transmitted by sheer pin, or safety release, be sure there is no binding which might prevent protective device from serving its function. Make repairs or replacements promptly.

(3) When stoker is shut down, make thorough inspection. Check wear on surfaces of feeder box sides, conveyor tube and retort. (If they are allowed to get too thin before replacement, serious outage will result.) Check wear on moving parts, check alignment: Check condition of dump grates. On stokers equipped with moving grate bars, check move-

LAST LONGER..

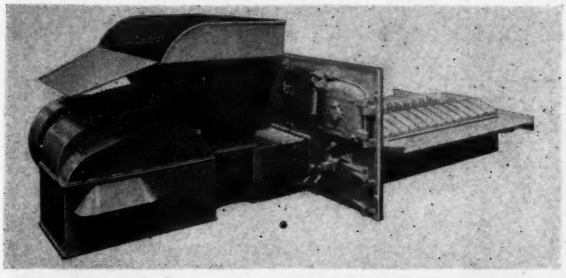
lower maintenance

ment of bars and see that proper clearances are maintained. Overall clearances to provide for growth of grate bars should be 1½ in. on small stokers and up to 2 in. on large stokers. If stoker has adjustment device to compensate for growth, use hand pressure only on adjusting screw. Where there is no adjusting device, remove grate bar or filler bars as may be necessary to provide proper clearance. (Excessive tightness of bars, usually resulting from growth, can cause extensive damage.)

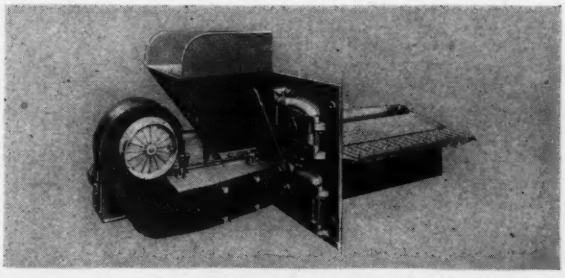
LUBRICATION

The use of the right lubricants at sufficiently frequent intervals at all points requiring lubrication is essential if unnecessary outages and excessive maintenance are to be avoided. Difficulties from inadequate lubrication usually result from a lack of attention rather than a lack of knowledge as to how, when and where to lubricate. A definite schedule for lubrication, regularly adhered to, is the answer.

TYPE E... A single-retort, underfeed stoker designed to burn either coking or non-coking bituminous coals. Applicable to boilers ranging from 150 to 600 rated boiler hp. Equipped with integral steam piston, electric or hydraulic drive.



SKELLY... A single-retort, underfeed stoker available in designs for burning either anthracite or bituminous coal. Applicable to boilers ranging from 20 to 200 rated boiler hp. Equipped with either electric or steam drive.



LOW RAM... A ram type, underfeed stoker designed to burn either coking or non-coking bituminous coal. Applicable to boilers ranging from 35 to 200 rated boiler hp, especially where head room and furnace volume are limited.

The C-E line of stokers is the most extensive on the market. It includes single retort, multiple retort, spreader, traveling and chain grate types.

OVER 17,000 C-E STOKERS HAVE BEEN PURCHASED TO DATE

Reprints of this advertisement on heavy paper available on request

A-913

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COCHRANE EQUIPMENT HELPS BREWERY CUT STEAM COSTS BY 27.5%

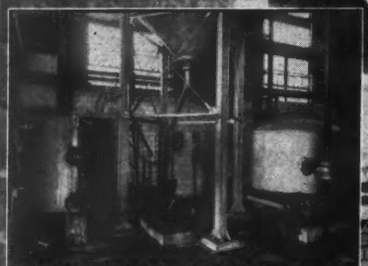
GRIESEDIECK WESTERN BREWERY
BELLEVILLE, ILL.

A COCHRANE Deaerating Hot Process Softener is installed as part of the modernized boiler plant of the Griesedieck Western Brewery, Belleville, Ill.

Also installed are a Cochrane Chemical Proportioner and tank, a Cochrane Vertical Filter, and a Cochrane Mechanical Flow Meter measuring total steam flow.

The Cochrane feedwater conditioning equipment safeguards a new 4-drum bent tube boiler which replaced three old boilers. Records of the new equipment as compared with the old show a saving in fuel costs alone of 27.5%.

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia, Pa.



COCHRANE CHEMICAL PROPORTIONER *at left*
COCHRANE VERTICAL FILTER *at right*

COCHRANE High Torque FLOW METER MEASURES TOTAL STEAM FLOW

Background Photo: SEDIMENTATION TANK OF COCHRANE DEAERATING SOFTENER EXTENDING THROUGH TWO STORIES OF BOILER HOUSE

Cochrane

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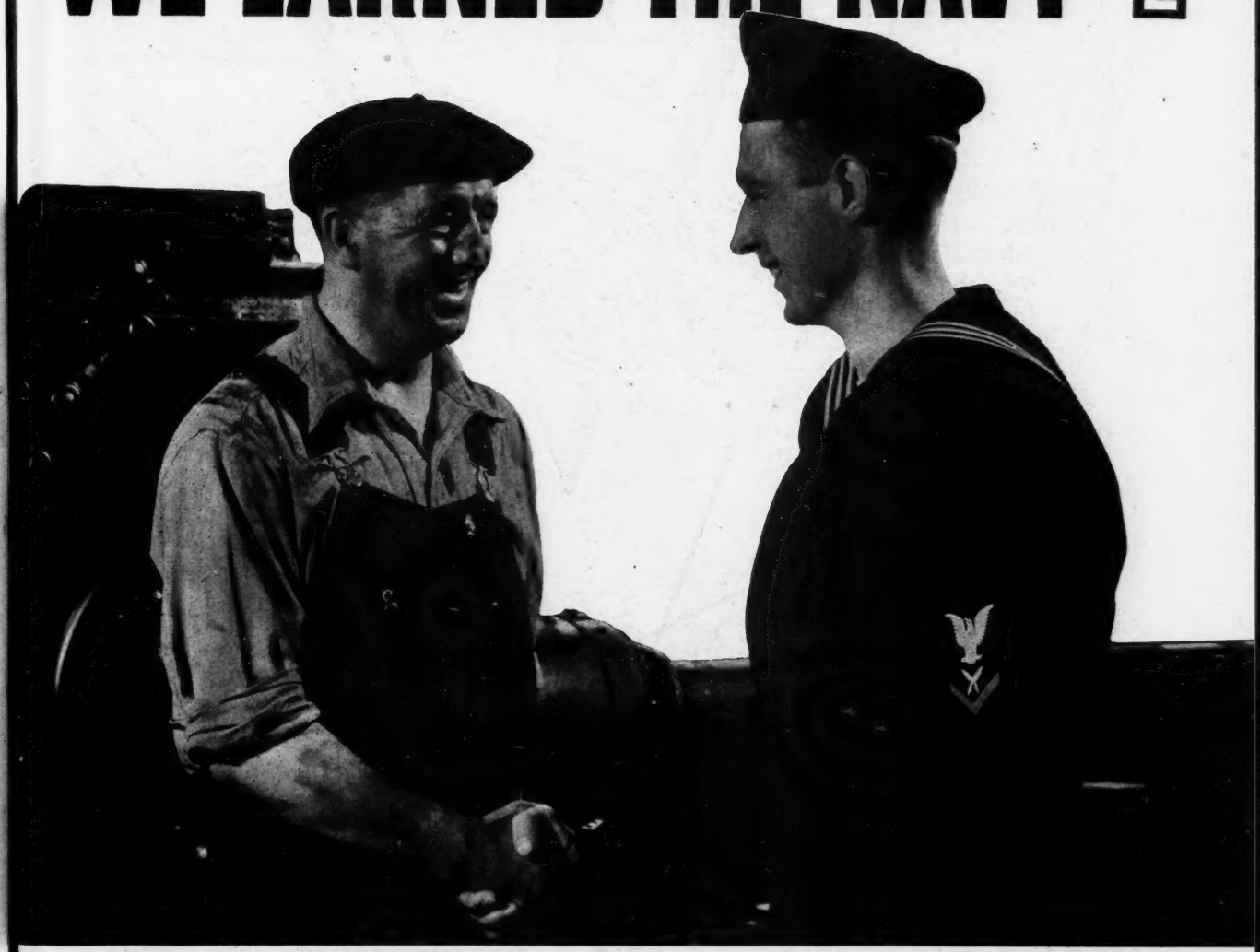

Our pledge to the Navy

To the United States Navy and to the Nation, we of American Blower pledge the unstinted devotion of our experience, our ability, our effort. Whether destined for use on the battle lines, or to equip other essential industries for production of vital material — the products of our efforts, we pledge, will continue to measure up to the standard of excellence that is worthy of the commendation, "Well Done." We are proud of the privilege of working under the Navy "E" burgee — proud to wear the insignia conferred on us. By our progress in production, we shall continue to demonstrate our patriotism and determination to win. We are mindful of our responsibilities. We are working, and shall continue to work, for Victory!

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FLUID DRIVES · DUST COLLECTORS

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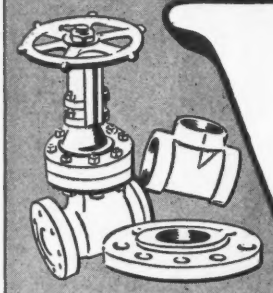
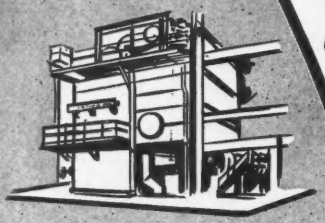
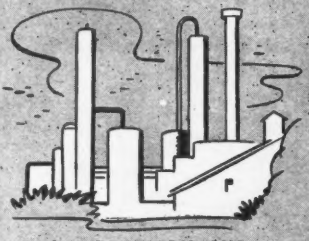


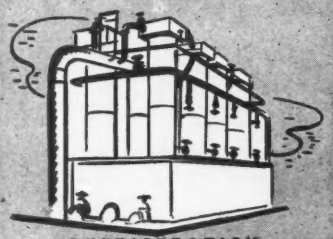
DROP FORGED STEEL VALVES, FITTINGS AND FLANGES



WATER TUBE BOILERS



OIL REFINERY AND CHEMICAL PLANT EQUIPMENT



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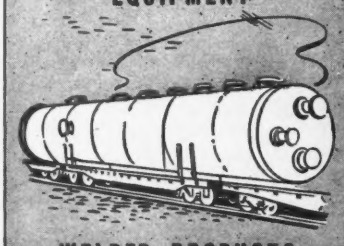

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1. Inconel resists relaxation up to high temperatures and may be used at high stresses up to 650° F. Above this temperature the stress must be lowered considerably and a slight degree of relaxation must be tolerated.
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3. "Z" Nickel may be used with high stress at temperatures up to 550° F. and with reduced stress up to 600° F.
4. "K" Monel may be used with high stress up to 450° F. and reduced stress up to 500° F.
5. Where other factors such as corrosion resistance are involved, Monel offers possibilities as a spring material for temperatures up to about 400° F. and at moderate stress levels.
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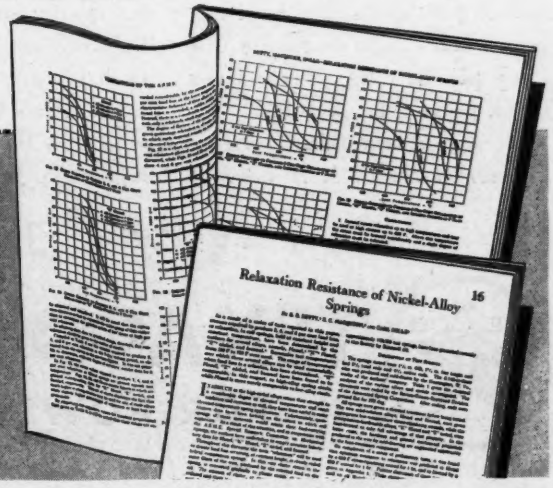

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JULY, 1942

VOLUME 46, No. 7

Cover: Coal pile at one of the stations of the Consumers Power Co., with 170,000 t. of coal stored 25 ft. deep using a drag scraper for handling and a bulldozer for compacting. The height of the pile can be judged from the steep slope in the center where the pile has not yet been filled in to the earth embankment. Note at the right corner the gentle, well compacted slope extending up, from the top of the track embankment, to the top of the pile. (Sauerman Bros., Inc., Photo)

What Leaders Say 51

Coal Storage Manual 53

- Why Store Coal Now? By Ralph E. Turner 54
- The Storage Problem. By George C. Daniels 58
- For the Small Plant. By Carroll F. Hardy 62
- Storing Coal Safely. By M. K. Drewry 65
- For the Large Plant. By Raymond J. Brandon 69
- Sizing and Preparation. By Joseph Harrington 74

Buick Factory Assembles Army Aircraft Engines. By Ralph E. Turner 77

Electrical Maintenance of Large Rotating Machinery. By John S. Askey 82

The Part of Correct Lubrication in Equipment Maintenance. By Sam S. Hansen 85

40,000-Hp. Motor Drive for Army Wind Tunnel 87

William Du Bois Duddell 89

A. S. M. E. Discusses Production and Maintenance 90

Prevent Smoke and Reduce Waste, S. P. A. Theme 91

The Oil and Gas Power Conference at Peoria 92

The Practical Engineer and Electrician 93

War News from the Industrial Front 118

New Equipment 120

Manufacturers' News 144

Manufacturers' Personals 150

News from the Field 154

New Engineering Books 156

For the Engineers' Library 158

Power Plant Construction News 168

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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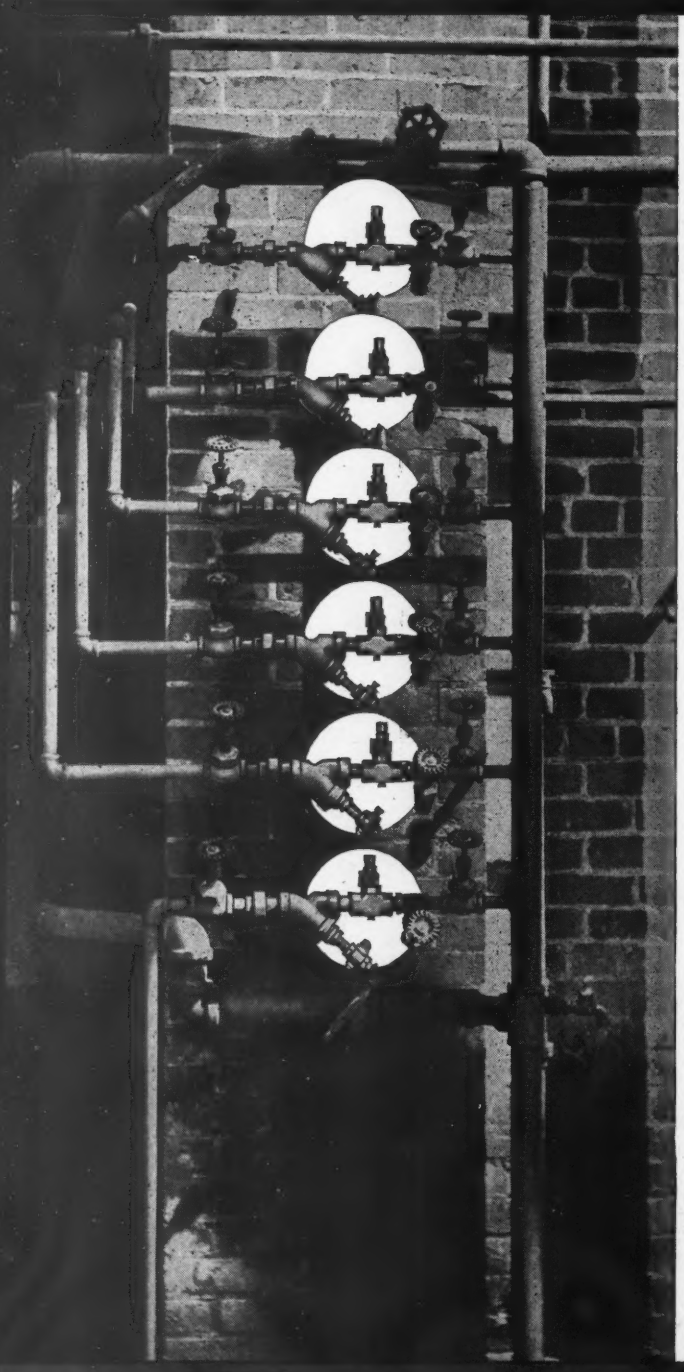
World's Largest Cotton-Seed Cooker is YARWAY TRAPPED



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WHAT LEADERS SAY

Utilities Must Forget Complacency

By DR. WILLIAM McCLELLAN

ONE OF THE greatest dangers confronting business organizations in general, and utility organizations in particular, in this day and age, is a state of complacency that is too evident to be overlooked. This is particularly true in organizations where customer relations are pleasant and mutually satisfactory.

By and large the customer relations between utilities and users of power are highly satisfactory to all concerned. Utility companies in the very great majority of cases are what might be called good organizations. They are competently managed; their service standards—usually set by a commission—are maintained to conform to standard requirements, and they have the reputation of giving service to their customers. In addition they realize that it is to their interest too, to build up their communities, and that if their communities do not progress and build up their potential for the sale of power will decrease.

An outstanding fact about the electric utility is its rapid growth and constant increases of capital. Capital investments are likely to be at work for 30 yr. or more before they can be put to use again. Compared to other lines of business or other investments, the fixed capital is very large, when contrasted with its working capital.

On the face of things, utilities in most cases have no competition; the local commission is set up to see that economies are effected and that maximum service is available at fixed rates. It is realized that duplications are costly and that the public in many cases would not be better served by sharp competition. This all places the additional burden on the wide awake utility executive to learn whether his organization is becoming too methodical, too routine, and too hidebound by traditional practices and means of operating.

Complacency is too close to smugness. It tends to stifle progress in management and lead it to the deep ruts of routine. Conservatism displaces courage with the net result that every innovation is regarded as daring, and is condemned. It goes untried. This is true not only in the operating end of an electric utility, although perhaps more prevalent, but it is correspondingly true in accounting, financing, commercial practices, metering, billing, customer relations and in general operation.

Many consider the electric utility industry as a young and vigorous industry. Surely, it is. It is if age is measured in years, and so is the United States, as countries go. Both the electric industry and the country have enjoyed phenomenal growth, and both have their greatest growth ahead of them. It must also be said that the speed with which both the country and the electricity utility field has expanded causes one to think of their growth as being parallel.

In no country, even one established 600 yr. or more, have the natives achieved the richness in their lives as has the American citizen in a period of but 150 yr. Businesses established this long don't match the strides that the electric utility business has made the past 60 yr. Yet complacency is a feature of success and age, and should be considered as such.

In critical times such as these, we should make certain that complacency is banished to the limbo of unprofitable operations. We cannot sit back supine in the assumption that we are doing the job in the best way, simply because we have never done the job in a different way. The electric utility is a monopoly in the community, and if we do not give the utmost in performance and service and the lowest cost, the community will suffer, and communities in corresponding circumstances advance. The emphasis is on community progress. Unnecessary waste, if there be such a thing, is bad enough, but careless waste is positively vicious.

It is our job to take the offensive and correct any situation that suggests inefficiency. Some governing bodies claim that private electric utilities spend too much on their construction, while the same governing bodies point to the smaller costs in their own construction. The proper cost of a line is not the original cost alone, but the total cost during its lifetime. And this includes maintenance and reliability of service.

The streamlining job is ahead. Old shop methods and obsolete equipment must be changed; redesigned if not replaced. Costs of operations must be reduced and cordial customer relations kept, and all with a view to building up service.

A 5 per cent reduction in operating expenses does not sound like a large amount, but when it is translated into dollars, a concern with a 20 million dollar operating cost would be saving a million dollars. Annually, that's a lot of money. The utility must follow the pattern other businesses are going by, and awaken from its lethargy and forget complacency.

Beware of complacency. Take a good look at other business and see what it is doing. Businesses differ from one another in part but basically they are all the same. The successful ones all want low costs, big services and genuinely earned profits. The utility must get in line. Complacency is defeatist. Out with it.

Our early development period is just about over. The public and our stockholders have a right to expect the results of "mass production". Mass production means dropping old shop methods and getting a production line started. Like the automobile manufacturers, we must cut our costs and at the same time keep up what we have been doing for years—giving the customer more and more for his money.

This is a streamlining job. We've been working in the old shop so long we are accustomed to its deficiencies. We may be complacent. We'd better find out if we are—or else.

We had better get ready for what's coming. Cold light is on the way. Package power with the Diesel engine will look good to a lot of fellows who will want to rehabilitate when war work is over. Those manufacturers with factories and workmen on their hands will make the packages and what a host of salesmen will be on hand to push them. We'd better not be complacent. We'd better have considerable intelligent dissatisfaction and curiosity.

DR. WILLIAM McCLELLAN, chairman of the board of the Union Electric Co. of Missouri, engineer and active utility executive, bases this article, written for the Union Electric Co. magazine on the rich experiences of a full and useful life. Before he was a utility executive, he was a builder of power plants (Cahokia, for instance). Before that he was a college professor and Dean of the Wharton School of Finance of the University of Pennsylvania. Thus he can look at our current problems with the eyes of a sound economist as well as those of a practical utility operator and engineer.

Chesapeake & Ohio Lines, Photo.

WHILE GAS, oil, gasoline and a variety of products are widely used as fuels, the bulk of the world's energy is still supplied by coal. As more and more of the hydro carbons are diverted for war purposes, coal will carry steadily increasing responsibility for meeting the increasing power needs for armament production and essential civilian services. Mines well scattered over the country have adequate production to meet all needs, man power at the moment seems adequate, but as this is being written Secretary Ickes is forecasting that this winter transportation for fuel will not be available "for love nor money." All plants with war work are cautioned to store "at least 120 da. supply of coal." Other plants, and domestic consumers too, will do well to heed the warning and be well prepared

COAL STORAGE MANUAL

WAR brought a sharp shift in values and many things of little or nominal importance in peacetime stand out in bold relief as key members of an emergency structure. One of these is coal storage—the spearhead of a three pronged drive on strategic positions needed to prevent flanking movements around the industrial front. ¶ One of these prongs is aimed at insuring a continuous supply of process steam and electric power for War Production in spite of unexpected interruptions at the mines, or, of transportation facilities, due to accidents, sabotage, or airraids. The second prong is aimed at more effective use of man power and mine facilities by uniform production throughout the year so as to minimize the usual seasonal slump in coal production, with idle men and idle equipment. The third prong, recently emphasized by the President in referring to the increasing importance of the distribution problem, is aimed at relieving transportation facilities of unnecessary duty during the fall and winter months when crops must be moved and the full brunt of the War Program will be felt. ¶ In normal times considerable quantities of coal are stored, principally by utilities and the larger industrials. This summer, large quantities will be stored by thousands of plants to whom the problem is completely new, adequate equipment unavailable and storage areas difficult to obtain. ¶ Much of this will be live storage—a few weeks' supply under constant movement and presenting no particular difficulty beyond segregation, breakage, variable moisture and dirt, common to all handling problems. Much of it will be dead storage, more or less permanent storage piles which must be well piled and sealed if spontaneous combustion is to be avoided. ¶ This can be done, even though inadequate or makeshift equipment must be utilized during this critical period, by following modern methods differing radically from those in vogue during the last war. The new layer method is well adapted to most anything from a wheelbarrow to a horse drawn vehicle. Earth moving equipment, of the tractor-tread-bulldozer type used by contractors, is well adapted to this service and of recent years has been widely used as auxiliary handling equipment for compacting, extending the range of regular equipment and effectively utilizing irregular storage areas. ¶ The following section, prepared by engineers who have lived with this problem for years and speak from practical experience, is presented, first, as a contribution to the War Effort, second, as an authoritative reference manual of permanent value. The spirit of Patriotism and Service which impelled the authors and their companies to share this vital information with the Nation in time of stress, will lead others to use it effectively to solve this emergency problem and to speed the Day of Victory!

WHY STORE COAL NOW? 54
By Ralph E. Turner

THE STORAGE PROBLEM 58
By George C. Daniels

FOR THE SMALL PLANT 62
By Carroll F. Hardy

STORING COAL SAFELY 65
By M. K. Drewry

FOR THE LARGE PLANT 69
By Raymond J. Brandon

SIZING AND PREPARATION 74
By Joseph Harrington

BIOGRAPHICAL NOTES ON AUTHORS 166

WHY STORE COAL NOW?

By September 1 railroad shipping will begin its movement of agricultural products and its seasonal peak load will interfere with coal shipments. Add to this normal load that imposed by war activities and coal users have good reason to provide now for future needs. Charts and other data are presented to aid managers in determining the amount of coal to store to help alleviate the coal shortage that appears imminent. Storage should be at least 2 to 4 mo. normal supply and the storage pile should be replenished as fast as used so as to carry over an unexpected emergency. In March utility storage averaged about 86 da. supplies, or from two to four times the industrial plant reserve, and during April the utilities increased reserves to 94 da. requirements

by Ralph E. Turner, Editor, Power Plant Engineering, Chicago, Ill.

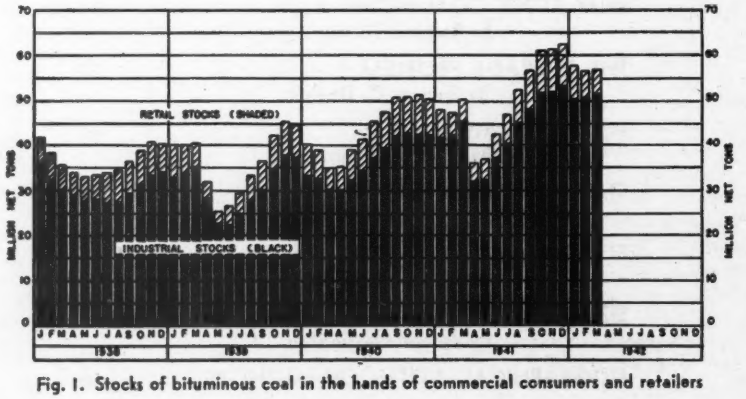
WHY ALL this agitation to buy and store coal now? That question is being asked all over the country. This question of coal storage is not new to the power field. Too many plants have been caught with an inadequate fuel supply during long continued labor difficulties at mines to treat the question lightly, for managers have found that a mere guess on their part has been ineffective in keeping the plant in fuel or requiring the payment of a severe penalty in price of fuel or curtailment of plant services. Many studies have been made to determine the best methods and means for storing coal at the plant, so that today very little loss due to deterioration or spontaneous combustion is experienced in modern plants.

With price control in effect, the question today resolves itself into one of supply and demand—will plant managers supply themselves now with coal sufficient to carry on their activities during periods to come when coal will be difficult, if not impossible, to get?

Each Plant Must Answer

The answer to this question must be made at every plant but a study of present conditions in the fuel and transportation industries should be of assistance in determining when to store and how much coal should be added to the storage pile.

That the coal industry sees the possibility of a severe shortage ahead is evidenced by a statement made by C. C. Dickinson, president of the National Coal Assn., at a recent meeting of the U. S. Chamber of Commerce. He pointed out that for reasons beyond its control, the industry is much concerned, if not alarmed, about the future, particularly during that period commencing about September 1, and is now endeavoring to make the consumers of coal and government authorities fully cognizant of its seriousness.


RETAIL STOCKS (SHADED)
INDUSTRIAL STOCKS (BLACK)
MILLION NET TONS
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1938
1939
1940
1941
1942

Fig. 1. Stocks of bituminous coal in the hands of commercial consumers and retailers

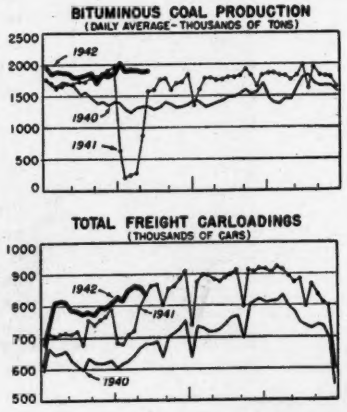


Fig. 2. Trends in coal production and freight carloadings over the past two years

Coal mines of the country are capable of producing 12,000,000 tons per week provided they have:

a. The necessary equipment and material to maintain the repairs, replacements, and equipment to retain the present production capacity.

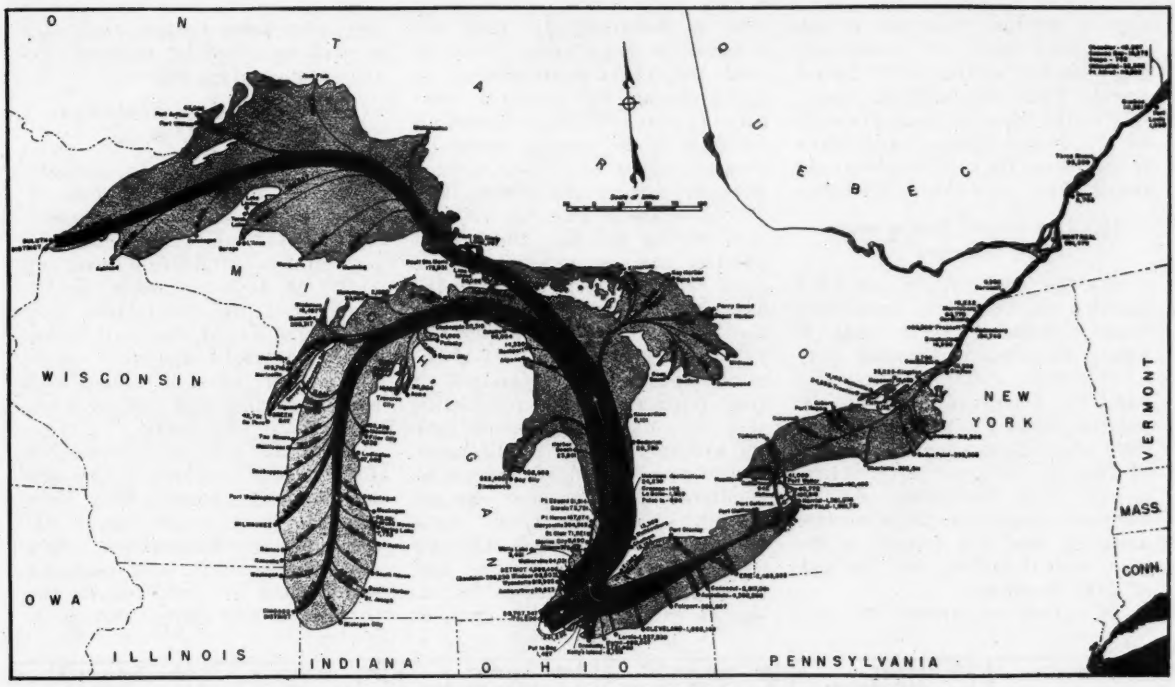


Fig. 3. Distribution of lake shipments of bituminous coal, exclusive of vessel fuel, to indicated destinations during 1937

b. The necessary labor to operate the mines at full capacity.

c. The required open-top railroad cars in which to load the coal.

Mine Operators' Requirements

Production of bituminous coal so far this year, according to government reports, has averaged a little above 11,000,000 tons per week, and since the middle of April the production has been holding at nearly 11,500,000 tons. Up to the present time, Mr. Dickinson reports, the industry has had an adequate supply of the essentials as is indicated by the production figures but changes indicated in the near future are expected to reduce capacity unless provided for immediately. This reduction in production is likely to come from one or more of the following causes:

1. Lack of materials for repairs and replacement and extensions to working places in the mines.

2. Steadily decreasing man power due to the operations of draft boards, rubber shortage and gasoline rationing, and competition with nearby industries.

3. Transportation limitations that are becoming more and more evident as war activities progress.

4. Maximum price regulations have an effect on production for the reason that the cost of producing coal at some mines is 50 to 100 per cent over that at others. Without proper consideration by the OPA some of these mines will be forced out of business.

All of these foreseen possible causes of coal shortage with the exception of transportation can and most likely will be taken care of by one or more of the federal agencies charged with the responsibility of coordinating the needs of industries. Transportation industries, however, are carrying extremely heavy burdens in the conduct of the war, burdens that are growing heavier every day as war industries turn out more products, troop movements increase and destruction of tankers and coast-going freighters forces shipment by rail.

Substitute Fuels

Again, the restriction in the use of oil and gas for some uses must result in the substitution and increase in the use of coal. Many industrial plants are now under construction which will soon require great amounts of coal, and in many cases these plants are located in places where only small amounts of coal were formerly used which requires the working out of new transportation schedules and car routing.

Open-top cars commonly used for transporting coal are also used for sand and gravel, the estimated shipment of which will be increased by about 15 per cent. Similar cars will be required in increased numbers in Michigan, Northern Ohio and parts of the West for the handling of sugar beets on account of the cane sugar shortage.

To these increases in the transportation load may be expected not only the normal seasonal increase due to the movement of agricultural products but a much larger load due to the greater crop which is expected.

The Remedy Is Coal Storage

Inasmuch as coal represents 20 to 25 per cent of the railroad tonnage, the coal industry is urging government authorities to use every facility at their command to increase the present stocks of bituminous coal above ground from the present 50,000,000 to 60,000,000 tons to at least 100,000,000 by the first of September which will give a safe backlog in the hands of consumers or immediately available for use in case regular deliveries are interrupted for any reason.

In the opinion of H. A. Gray, Acting Director of the Office of Solid Fuels Coordination, stated at the recent Chamber of Commerce meeting, the coal problem, serious as it is, has a relatively simple remedy. Production and transportation of the year's supply must be spread more evenly over

the 12 months. This can be accomplished only by purchasing coal now and storing it for future needs. That, he believes, would relieve the seasonal peak pressure on mines and carriers and make it less likely that shortages would result from overtaxed facilities.

Hand to Mouth Buying Must Be Changed

As the coal supply has been handled in the past, consumers have purchased their requirements as needed, keeping only a minimum storage supply on hand for emergency use but depending upon the mines and carriers to maintain a continuous flow of fuel to meet current requirements. With disruptions due to wartime conditions, that practice must be modified today or the plant will definitely run the risk of fuel shortage.

Mr. Gray recognized that the war is handicapping both the production and transportation of coal, but directed attention to a chart giving the seasonal variation of coal production in various districts of the country which indicated what has been normal practice during the years 1936, 1938 and 1940. This chart shows that during the fall and winter months coal is produced at a peak rate greatly in excess of the average monthly requirement for the year. During the spring and summer, when a large part of the mine capacity is idle for lack of coal purchasers, the production rate is considerably lower than the average monthly requirement. By cooperative efforts, every bituminous coal consumer can assist in straightening out these curves and thus assist in relieving congestion in coal mining and transportation, the normal activities of which come to a peak at about the same time of the year, as will be noted by reference to the accompanying charts.

Estimates Average Production 11,000,000 T. Weekly

Government estimates indicate that close to 570,000,000 tons of bituminous coal will be mined during 1942, and this would necessitate a production rate of 11,000,000 tons per week. Every week that the production and transportation of coal fall below those figures means that additional coal must be mined and hauled during some other week to make up the deficit.

Railroads are now experiencing difficulties in handling their loads and in recent months they have been required to use about 600 more freight locomotives every day to haul oil into seaboard states than it took before the petroleum emergency and it is

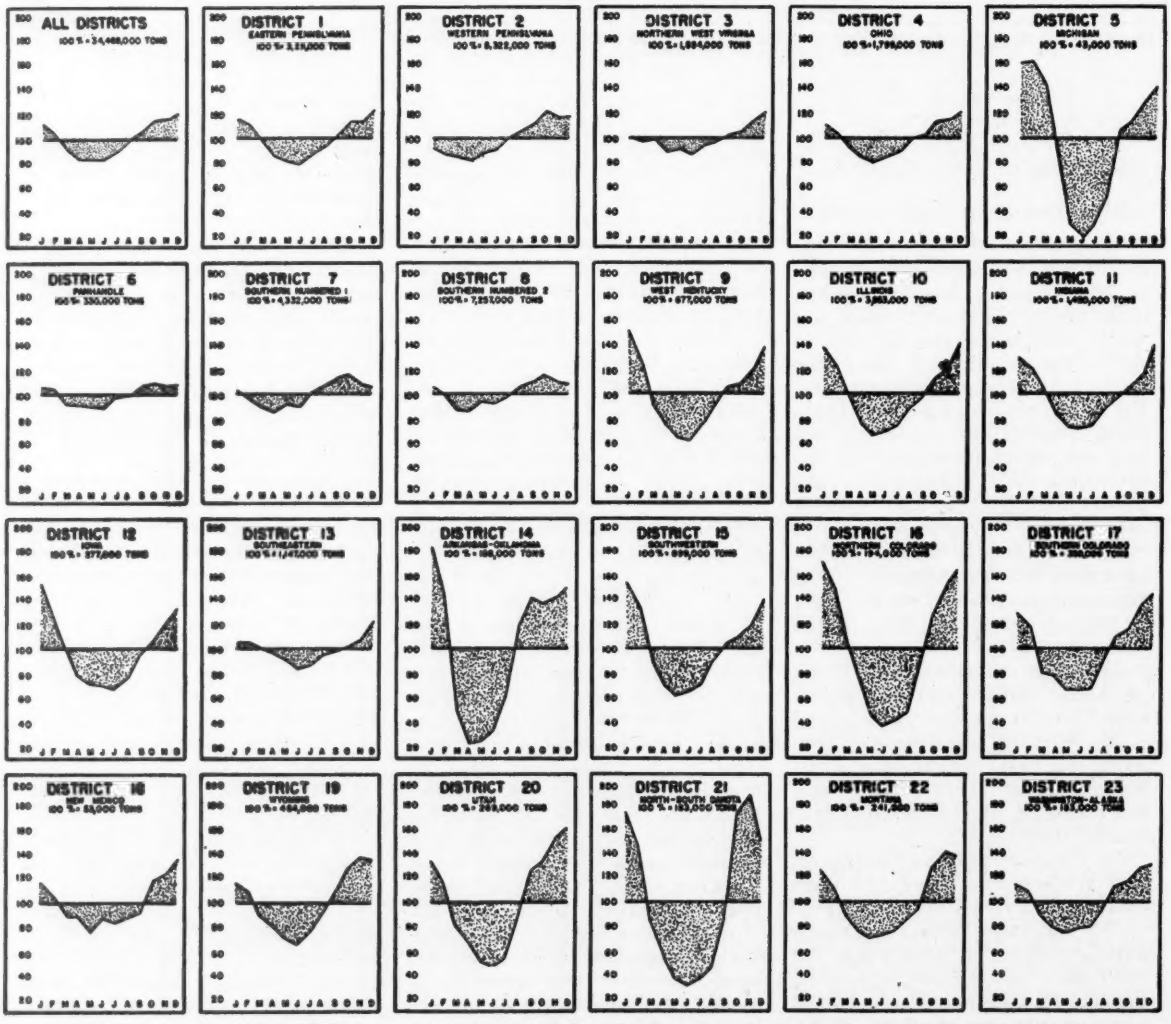


Fig. 4. Seasonal variation of bituminous coal production based on the average production for the years 1936, 1938 and 1940

estimated that it will take about 150 additional locomotives to haul the coal all the way from the Southern Appalachian field into New England than was necessary when Tidewater collier routes could be used.

The Eastern Seaboard Requires 750 Locomotives

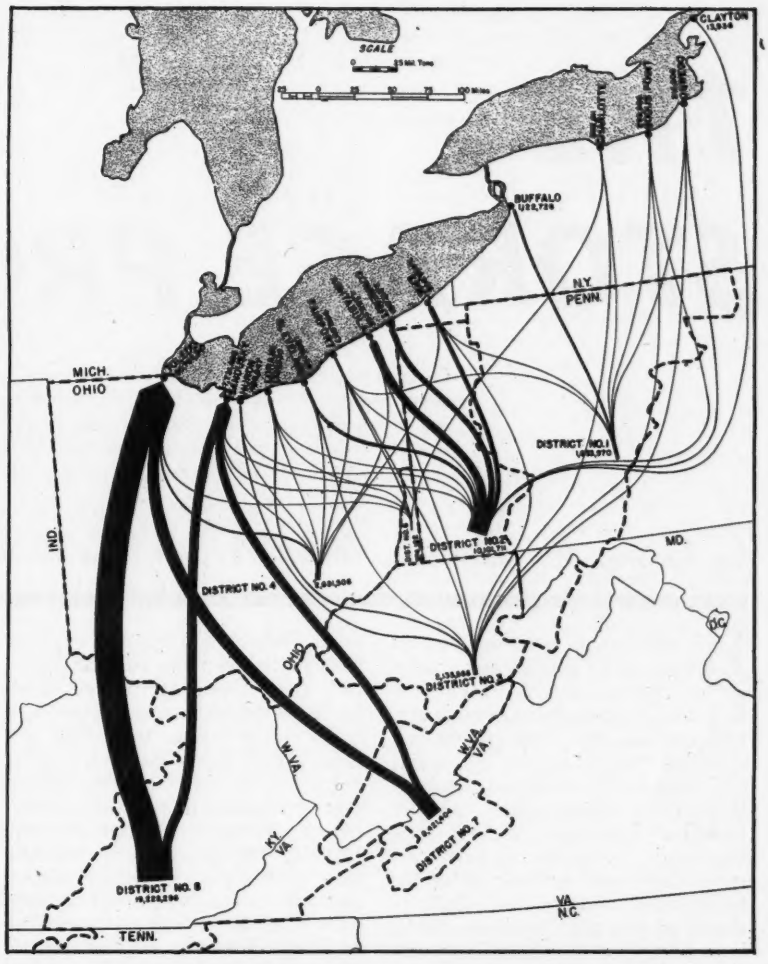
While the 1942 locomotive construction program calls for 900 engines to be built, this is only 150 more than will be required to take care of the new Eastern Seaboard fuel situation alone. Additional coal cars will also be required because of this situation.

Coal transportation is a complex problem as can be appreciated by a study of the two maps showing the tonnage that is shipped from mines in the Appalachian region, via railroads and Great Lakes carriers, into the Central and Northwestern states, and Canada. The coal is moved by rail from the mines to the lower lake ports, where it is transshipped by vessel to points along the lake system. There, some of it is consumed, or stored for future consumption, and the rest is reshipped inland by rail or truck to other places. Some of these inland movements from the docks travel as far west as the Dakotas. Other coal routes are just as complicated but these maps serve to give an idea of the problems that are encountered in planning and coordinating coal transportation.

Replenish the Storage Piles as Soon as Used

Government authorities are working out an emergency coal distribution system which will be recommended for use only as a last resort measure, after all other efforts to keep essential users supplied have failed. The best and only way to delay or avoid the necessity for having to institute such an undesirable system, says Mr. Gray, is to get the greatest amount of coal possible into the storage piles now, then keep the piles replenished as fast as the coal is used.

An idea of coal storage practice for the past few years may be obtained from Fig. 5 which shows the stocks of bituminous coal in the hands of commercial consumers and retail dealers.



*** TONNAGE FROM ORIGIN DISTRICTS TO LOWER LAKE PORTS**

PORTS	District No. 1	District No. 2	District No. 3	District No. 4	District No. 6	District No. 7	District No. 8
Toledo				784,197	30,814	5,511,085	14,881,313
Sandusky		18,350		54,832	3,485	2,130,181	6,548,885
Huron		881,950	5,488	885,488			
Lorain		514,826	798,884	139,770	84,514		
Cleveland		1,188,882	882,136	856,770			
Fairport	142,817	64,775	882,864	139,448	284,815		
Ashtabula		2,454,870	815,851	694,159			
Conneaut		2,817,091					
Erie	5,835	1,780,981	814,448	858,195			
Buffalo	1,182,785						
Oswego	82,795	154,885	88,888				
Sodus Point	68,358	87,007	820,822				
Charlotte	858,479		3,130		1,014		
Clayton		15,638					

Fig. 5. Lake shipments of bituminous coal exclusive of vessel fuel to lower lake ports during 1937 by origin districts

In the country as a whole, the electric power utilities in March of this year had 13,891,000 tons of bituminous coal in storage which represented about 86 days' supply. The consumption during the month was 5,019,000 tons. Among other industries, government statistics report byproduct coke ovens with 33 days' supply on hand; steel and rolling mills, 33 days; coal-gas retorts, 61 days; and cement mills with 42 days of bituminous coal supply in storage. The electric power utilities in the various sections of the country have reported their days' supply of bituminous coal on hand as follows:

In New England, 84; Middle Atlantic, 68; Ohio, 82; Michigan, 151; Illinois-Indiana, 95; Lower Missouri Valley, 60; Lake Dock Territory, 105; Southeast, 98; Southwest, Mountain and Pacific, 73.

From this review of the coal storage situation it is apparent that a period of coal shortage is imminent in the fall and early winter months, the results of which can be alleviated only by early storage of coal to an amount sufficient to care for the needs of the plant for two to four months, depending upon distance from mines and transportation facilities available.

THE STORAGE PROBLEM

Fundamentals of coal storage principles and practices; storage with complete ventilation; storage with no ventilation; factors influencing deterioration in storage; compacting with bulldozers, horse drawn scrapers and water; effect of coal type and size; coal density, free and compacted; slopes as danger points and protection with embankments, earth, fine coal and asphalt; recompacting to stop heating; use of thermometers

by George C. Daniels, ***Mechanical Engineer, Commonwealth & Southern Corp., Jackson, Mich.***

DURING the previous world war many industries were forced to use coal with which they had had no previous experience, and, added to their operating troubles was the loss of much coal due to spontaneous combustion in the storage piles. In the technical literature of that time appeared numerous articles on methods of storing coal, including underwater storage, the effect of depth of the pile, intricate ventilating systems under and through the coal piles, elaborate systems for determining the temperature in all portions of the coal pile, and an attempt to classify coals between those that could and those that could not be stored readily. The last was supposed to be influenced by the sulphur content, etc., all of which tended to complicate what really is a simple problem.

Two Storage Methods

All coals except anthracite absorb oxygen with resulting spontaneous heating. The rapidity of heating depends upon the quality of the coal, those of lowest rank tending to heat most rapidly.[1] The rate of oxygen absorption and consequent heat generation at normal temperatures decreases with time, but the heating increases rapidly with temperature. ature.

Spontaneous heat generated must either be removed rapidly enough to keep the coal temperature from rising, or the air must be excluded to such a degree that fresh oxygen will not reach the coal. With either method, practically all coals may be safely stored without danger of spontaneous combustion. The greatest liability for spontaneous combustion occurs when enough air is allowed to reach the coal to support combustion but not sufficient to carry away the heat as fast as it is generated. While either method of storage can be used successfully, extreme care must be used that the same method is used throughout the entire storage pile, and continuous care must be exercised in the method of building up the storage pile.

The first method mentioned consists of providing sufficient ventilation to keep the coal cool throughout the pile. Attempts have been made to do this by installing ventilating ducts or tun-

Fig. 1. Coal being stored and compacted by a bulldozer only. Note the smooth, compact surface at the left, the gradual slope compacted by the tractor tread in the center and, at the left, he almost vertical cut bank where coal has been reclaimed from the well packed pile. The front cover (caption on contents page) shows a drag scraper installation at one of the corporation's other stations

[1]See Coal Changes During Storage by V. F. Parry and John B. Goodman of the U. S. Bureau of Mines, POWER PLANT ENGINEERING, p. 64, June, 1942. Laboratory and field investigation of storage of Colorado Sub-bituminous coal-drying loss, degradation and friability as affected by different methods of storage.

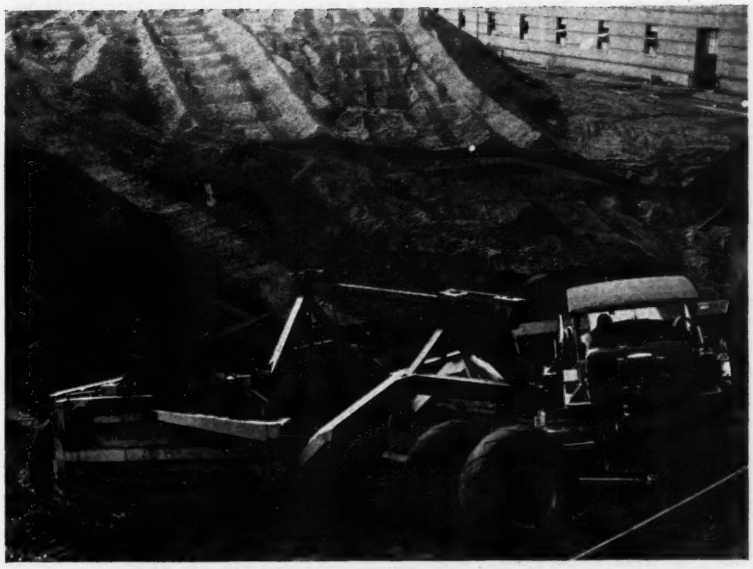


Fig. 2. Bulldozer and carry-all hauling storage coal at a large Eastern industrial plant

nels through the pile. These are of no value unless the coal above or around the ducts and through the pile has sufficient space to permit free circulation of air and in this event they would not be required. If the coal has insufficient air space for good circulation of air, the ventilating ducts may actually promote spontaneous combustion. Oxidation takes place at the coal face and the finer the coal the greater the surface exposed and the more rapid the heat generation. Air circulation through fine coal may readily be reduced to a point that the heat generated cannot be carried away as fast as formed and spontaneous combustion results even in very small or low piles.

Sized Coal Is Best to Store

Logically then, the best coal to store under these conditions are the sized coals (or those with the fines removed) which will oxidize more slowly and which allow air to circulate through them. When storing this kind of coal, care must be exercised that the coal is not broken up nor compacted by the storage operation, by dropping the coal from too great a height, trucking over the pile, or dragging the coal, especially if a friable coal is being handled. The storage of sized coal, or coal with the fines removed, is usually more expensive and also requires the storage coal to be crushed before use unless hand fired equipment is used.

The second method of storing coal mentioned above consists of compacting the coal so that it receives insufficient air to permit continued oxidation to take place. Segregation of the coal must be eliminated. Coal dropped on a pile from a bucket or belt will always segregate. The fines will stay in the center of the pile and the coarse coal roll to the outside, resulting in an ideal condition for rapid heating. Such piles must be rehandled and spread uniformly over the storage area and compacted in layers 6 to 12 in. deep. The easiest way to accomplish this by means of a caterpillar tread bulldozer that levels off the pile and compacts it at the same time.

Compacting action of the caterpillar tread bulldozer does not depend upon its weight, which is only 7 to 9 psi. of tread area, but upon its action in getting the small particles interspersed between the larger ones. Heavy rollers producing much greater unit pressure do not compact the coal even when deposited in thin layers as well as does the bulldozer.

Density Changed by Compacting

Coal compacted by bulldozers will weigh between 62 to 67 lb. per cu. ft. compared to loose coal of approximately 50 lb. per cu. ft. Coal piled with the ordinary methods will rarely exceed 58 lb. per cu. ft. in the bottom layer of a 20-ft. high pile after many years of storage. When excavated, coal that has been compacted and stored properly will stand with vertical walls. Underfoot the coal will be very firm and hard and water will run off readily even on very slight slopes.

Bulldozers and Horse Drawn Scrapers

The most economical way to handle and compact coal in large storage piles where the haul is greater than 100 to 150 ft. is with a caterpillar tractor pulling a wheeled scraper from which the coal can be distributed in even layers. For smaller piles the bulldozer alone can be used economically. For very small piles a horse drawn scraper might be used if mechanical equipment is not available.

Trucked coal can be used to form the storage pile if the coal is dumped in thin layers and driven over, but the coal must be dumped over the entire storage area and built up so that the trucks do not dump over the edge of the pile. When very fine coal, say ¼ or ⅜ in. screenings are stored in this manner without the use of a bulldozer, better compacting and better traction is secured for the trucks operating over the coal pile if sufficient water is used to wash the fines into the pile, much as sand is packed on the beach.

Mine Run Should Be Crushed First

Sized coal or coal from which the fines have been removed cannot successfully be compacted and if attempted, or if put into the same pile with slack or fine coal, will generally result in fires. Mine run to be stored by the compacting method should first be crushed or screened and the sized coal put into a separate pile and definitely separated by a passageway from the compacted coal pile.

Most critical portions of the coal storage pile are the slopes where segregation is usually most pronounced and where the wind forces air into the pile. Unless the slopes are carefully prepared, fires frequently occur at that point and progress into the pile. Several methods have been used to protect the edges of the pile. When using a bulldozer it should run up and down the slopes as the pile is being formed. This successfully compacts the slopes, but the incline is considerably less than the angle of repose of approximately 45 deg.

Where the storage area is limited, this is a disadvantage in that it reduces the volume of the pile.

Table I. Comparison of coal handling costs for 14 plants, showing the type of equipment and a breakdown of fixed and operating charges

Plant designation	Coal delivered by water, rail, or truck	Year installed	Capacity to bunkers tons per hour	Cost of installation including docks, trucks, pits, cranes, conveyors, etc.	Years represented by data	Tons coal burned per year	Load factor on coal handling equipment	Maintenance cost cents per ton	Operating labor cents per ton	Total operating costs cents per ton	Fixed charges based on 12% per annum, cents per ton	Total fixed and operating costs, cents per ton	Description of System
A	W	1939	400	$ 691,000	1940	124,000	3.5	1.3	5.0	6.3	67.0	73.3	Coal delivered on dock by self unloading lake boats, gantry crane to storage, or to belt conveyors to plant.
B	W	1925	350	1,220,000	37-39	382,046	12.5	5.3	7.6	12.9	38.1	51.0	Gantry crane from lake boats to storage, or by car and belt conveyor to plant. Auxiliary drag line storage.
C	W	1928	250	655,000	38-40	547,574	25.0	4.2	4.0	8.2	14.4	22.6	Clam shell from river barges to belt conveyors to plant or to Lidgerwood storage.
D	W	1928	125	978,000	35-40	175,879	16.1	4.8	6.6	11.4	66.8	78.2	Clam shell from ocean steamers or barges to belt conveyors, to plant or to drag line storage.
E	R	1939	200	360,000	1940	196,000	11.2	.7	6.1	6.8	22.0	28.8	Cars discharge by gravity into pit, to belt conveyors, to plant or to drag line storage.
F	R & T	1939	125	180,000	1940	122,924	11.2	4.5	6.4	10.9	15.8	26.7	From cars by gravity to pit, to belt and bucket elevator, to drag line storage or to plant by belt.
G	R	1936	100	212,000	1940	79,360	9.1	1.9	7.5	9.4	32.0	41.4	From cars by gravity to pit, to belt and bucket elevator, to drag line storage or to plant by belt.
H	R	1913	75	66,000	36-38	109,000	18.7	2.4	5.3	7.7	7.3	15.0	Stationary tower with clam shell bucket from cars to distributing belt. Locomotive crane for storage.
I	R	1925	75	112,000	36-38	217,566	33.0	2.1	4.4	6.5	6.3	12.8	Locomotive crane with bucket unloads cars to pit, to chain and bucket elevator, to scraper conveyor. Locomotive crane for storage.
J	R	1927	60	160,000	38-40	62,606	11.9	6.1	9.8	15.9	30.7	46.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Locomotive crane for storage.
K	R	1928	60	164,000	37-39	43,860	8.3	4.9	10.1	15.0	45.6	60.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Bridge crane for storage.
L	R	1928	50	97,000	37-39	54,636	12.4	4.8	8.1	12.9	21.5	34.4	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Bridge crane for storage.
M	R	1920	40	20,000	39-40	40,077	11.4	3.4	6.7	10.1	6.0	16.1	Cars discharge by gravity to shallow pit, to inclined scraper conveyor, to bunkers. Storage by portable conveyor.
N	R	1937	150	185,000	1940	275,376	21.0	-	-	10.6	8.1	18.7	Cars dump into pit, to skip hoists, to belt distributors. Storage by locomotive crane and bulldozer.
						Average	14.8	3.8	6.7	10.3	27.2	37.6	

More coal can usually be placed on a given area by the compacting method, however, for the depth of the pile is not limited and can safely be carried up to 20, 30, or even 50 ft., provided there is sufficient ground area to obtain the proper slopes. Earth embankments with a 2 to 1 slope or excavated basins with earth slopes afford ideal protection, but make the removal of the storage coal more difficult.

Slope Protection With Fine Coal or Asphalt

Loose coal on the slopes may be removed by cutting back at the bottom of the slope until very steep slopes of compacted coal remain. This together with forming the top of the pile slightly rounding results in almost perfect draining and the coal pile will remain remarkably dry. Still other but more expensive methods consist of covering the slopes with very fine coal, almost pulverized, to a depth of approximately 12 in. which is held in place by lump coal or by sealing the slopes with asphaltic materials.

Halfway measures in storing coal that is liable to spontaneous combustion will not produce results. Proper storage is no more expensive in first cost than improper storage even though no fires result, due to the ability to store more coal on a given area and in maintaining the coal dry and in good condition.[2] If any portion of the compacted pile should become hot and steam due to improper compacting, fires can frequently be prevented by compacting the surface by a bulldozer until the air circulation is stopped when the temperature of the heated portion in the pile will slowly fall.

Use of thermometers throughout the coal pile used to be considered essential to detect local heating. Their use entailed considerable time and expense and usually anticipated trouble only a few days ahead of visible evidence and seldom in time to allow remedial measures to be taken to correct the condition.

Under present conditions it appears likely that more coal will be stored this season than customarily and that the choice of coal to be stored will be somewhat restricted. For some plants the storage of any considerable quantity of coal may be a novelty, while others will merely augment their stock and use storage equipment already provided for that purpose. For the latter class, the shift in coal or coal sizes may be the most troublesome.

All of the equipment for handling storage coal in use today, including drag scraper installations, but excepting bulldozers or wheeled conveyances with controlled discharge, may produce segregation of the coal and will not compact the pile. It is therefore necessary to rehandle or level off the initial piles and spread them in thin layers and compact the coal as previously described to insure safety from fires in storage.

Handling Costs

Under present conditions, with priorities and critical materials, a detailed discussion of handling equipment is hardly in order, for present equipment must be utilized. The question of handling costs does, however, enter into the picture and the figures given by Table I are of more than passing interest.

It is interesting to note from

[2]See Coal Handling Changes Cut Costs and Increase Capacity by Paul Woodnorth of the Interstate Power Co., Dubuque, Ia., POWER PLANT ENGINEERING, p. 60, March, 1942. Changes in handling and storage practice quadruples storage capacity in same area, eliminates oxidation and heating and increases station efficiency 4 per cent when operating on storage.

this coal handling cost tabulation, which covers 14 plants of varying coal handling capacity, that the total fixed and operating costs for handling coal per ton do not decrease with the capacity of the plant. This is rather surprising, but it is difficult to justify coal handling equipment on an economical basis. The cheapest way to unload coal is by hand and the cost of handling coal in any coal yard is considerably below any of the figures presented in this tabulation.

Utility Emergency Equipment and Storage Units

Coal received by rail generally comes in hopper bottom dump cars, but in some localities coal is shipped in flat-bottom cars which may or may not be provided with dump bottoms. Such cars must be unloaded with a grab bucket or a car dumper. Delivery by truck from nearby mines is becoming more prevalent, and provisions for such delivery have been made by many plants.

When the amount of coal to be handled increases to the point that it is no longer possible to use simple and direct methods for handling coal by hand, considerable expense is entailed to provide the additional capacity by the installation of coal handling equipment.

Oftentimes the cost of handling coal to and from storage, considering both the fixed and operating costs, is excessive. Frequently the equipment required to store and reclaim coal involves a larger capital expenditure than the equipment to convey the coal to the plant.

Adaption of Earth Moving Machines

Attention has been called to this feature of coal handling since it is believed that much simpler methods are available for handling coal to and from storage that represent a very small initial investment and also low operating costs. This can be accomplished by means of equipment that has been prevalent on road building and excavation projects but has not received much attention until recently for handling coal. This equipment consists of a Caterpillar tractor with a bulldozer or angledozer in the front and a wheeled scraper in the rear, whose filling and dumping operations are controlled by the tractor operator. This kind of equipment is ideal for handling storage coal.

Equipment having a capacity of approximately 18 cu. yd. per load will handle approximately 1000 t. per 8 hr. for a distance of 400 or 500 ft. and at a total cost, both fixed and operating, not exceeding 5 c. per t. As additional handling capacity is required, additional equipment can be procured or the existing equipment can be used over longer hours. For small storage piles the bulldozer alone can handle the coal economically for a distance of 50 to 200 ft., depending upon the size of the equipment.

This above-mentioned method of storing coal is available to small as well as the large plants with equal facilities and does away with multiplicity of coal tracks and provides more storage space on the ground. This equipment also compacts the coal so that a greater quantity can be piled in a given space and also prevents spontaneous combustion by eliminating the possibility of air circulation through the coal pile.

Another important advantage of using bulldozers and wheeled scrapers, and very important for some locations, is that very irregular areas with irregular contours of the ground surface can be used to store coal, which otherwise might present a difficult problem to reach economically by other means. No preparation of an area to be used for coal storage need be made other than clearing off the ground.

The small plants with restricted coal storage areas need not fear that its cost of handling coal to and from storage will be excessive nor necessarily greater than at a larger plant handling large volumes of storage coal if due consideration is given to methods outlined.

"One or two lumps this morning, your Lordship?"

[3]The question of coal handling practice and equipment was developed in detail in a paper, Coal Handling Systems for Central Stations, delivered by the author before the A.S.M.E. Semi-Annual meeting at Kansas City, June, 1941.

FOR the SMALL PLANT

Storage pile height for different conditions; ground preparation and drainage; storage in layers; emergency handling equipment; sealing top and sides of piles; air leakage prevention; provision for taking temperature readings; detection of hot spots; smothering fires; period of maximum danger; underwater storage; effect of coal size and type on storage properties; five rules for small plant to follow to avoid storage difficulties

by Carroll F. Hardy, ***Fuel Engineer, Appalachian Coals, Cincinnati, Ohio***

COAL STORAGE by large and small consumers is of paramount importance, dictated by the needs of our country at war. It is imperative that small industrial plants, as well as the larger ones, make adequate preparation for the storing of sufficient coal to carry over any period that may develop in future months when a temporary interruption in transportation facilities, or supply, may occur. The nature of consumption of coal leads to peak demands on both the railroads and the mining operations at the same time of the year.

With world conditions as they are, circumstances dictate that stock piles be created so as to spread coal production and coal transportation more evenly over the entire year. Although the stocking of coal has been, and is today, being practiced by many utilities and large industrial consumers, the problem of coal storage will be new to many of the smaller users who depend almost entirely upon an interrupted flow of a given coal from producer to consumer. It is suggested that wherever possible a coal stock pile, sufficient to last at least 120 days, be created.

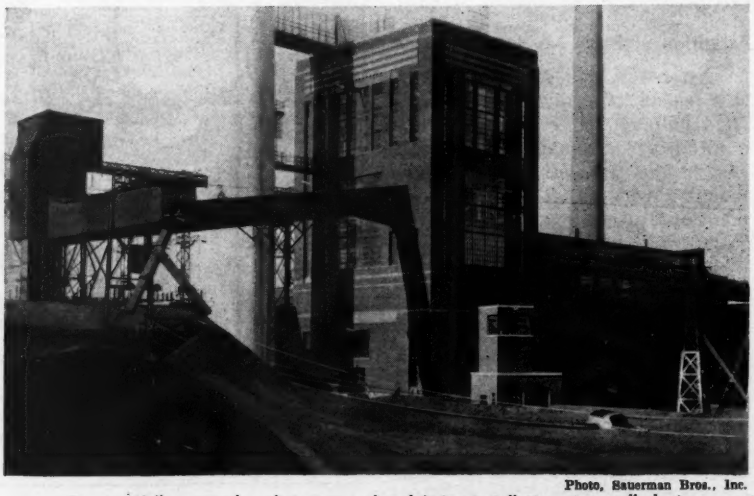
Proper and safe storage of coal for long periods has been developed in recent years. Today coal in piles made by the building of horizontal layer upon layer up to some 20 ft. in height may be stored for an indefinite period of time without fear of excessive heating and the attendant result, spontaneous combustion. In general, however, it is advisable to pile the coal to moderate heights, only 12 to 15 ft. In small industrial plants probably a height of 6 to 8 ft. will meet all requirements.

Preparation of Ground

The fact that coal must at some future period be recovered and used is often not given sufficient thought when coal is put on the ground and a considerable loss results which might have been prevented had the ground been properly prepared. The ground upon which the coal is to be stored should be smooth and free from cinders, ash, previously stored coal piles, machine turnings, and all types of industrial waste as well as vegetation. The leveling of the surface by means of a road grader or drag will greatly facilitate the recovery of the coal.

If the coal is to be stored in a bin or hopper, old coal should be cleaned out, including even relatively small amounts of wet coal, dust, and dirt, which is often overlooked. Surface drainage should be away from the coal pile and no drainage of water contaminated with oil, cutting compounds, soap, or other industrial waste should be allowed to flow through the coal.

When placing coal in storage the safest method is to unload it on the pile in layers from 2 to 4 ft. thick. When a clam-shell



Photo, Sauerman Bros., Inc.

Fig. 1. Well arranged coal storage and reclaiming installation at a small plant

bucket is used, or a bulldozer is available, this process is very simple. If a portable conveyor is used, it may be possible to move it sufficiently to distribute the coal over the area to be covered by the pile and thus deposit the coal in layers. If the coal is discharged from a fixed spout on a silo or bunker, the coal must usually be distributed by some other means.

A bulldozer or a road grader pulled by a Caterpillar tractor is ideal for this as it compacts the coal as it moves it. However, this equipment is rather scarce at present. A slip scoop, or other earth-moving device, attached to a tractor or truck, may also be used for this purpose. Each layer should be compacted by a road roller or any other means at hand.

Layer storage tends to prevent segregation and is valuable from two angles: (1) it assures a fairly uniform size consistency when the coal is recovered for use in the plant; (2) it prevents chimneys of coarse coal which are formed when coal is dropped from the same point to the total height of the pile, as the coarsest coal always rolls to the outside of the conical pile. If piles are so built as to be dense as possible, the air flow will be retarded. Therefore, great care should be used that the coarse and fines do not become segregated.

Sealing

Sealing the top and sides of a large coal pile with an airtight continuous layer of fine coal, plus a second outside covering of larger coal to prevent wind and rain erosion, has been found practical and effective by some large industrial concerns. Coatings of asphalt also have been used with success to preserve very large coal piles. The smaller plants will not need to do this, particularly if high-grade coal is stored. The question has been raised as to the advisability of oil coatings on storage piles. Inasmuch as the present emergency requires the use of all available oil-tank cars, any method such as this is probably out for the duration, as the priorities will not permit the use of oil for treating of coal.

Care should be taken to avoid air leakage to the pile through interstices around foreign objects (such as posts, brickwork, etc.) or through porous bottoms, such as coarse cinders. The practice of ventilating with pipes may cause local overheating and often does more harm than good. It is usually not realized what a large amount of air passes through slits, cracks, ill-fitting gates and coal handling and storing equipment in general.

Fig. 2. By a little ingenuity small irregular storage areas can be made practical

If coal is piled, for example on the ground, the sides of the pile give opportunity for air movement; therefore, coal placed level in a storage area having air-tight sides and bottom would give less trouble from spontaneous heating. However, small diameter pipes extending vertically into the pile at intervals of 25-ft. centers, or on low-grade coals even closer, may be used for checking the temperature, and are valuable as a safety precaution, particularly when the coal is to be stored in a large pile. Discarded steel, or iron pipe 2 in. in diameter may be used; old boiler tubes serve this purpose adequately.

Detection of Heating

Heating may be detected by the odor given off from the pile or by thrusting iron rods into the pile and feeling them with the hand, or by a thermometer. Steam should not be confused with smoke, for water vapor coming out of the pile in winter time may produce visible steam when there is no appreciable heating within the pile.

Heating of stored coal seems to be due to the action of the oxygen of the air on the coal surface, especially if it is a freshly exposed one. This action generates heat. If the heat is not dissipated, the temperature will continue to rise. The oxidation is more rapid at increased temperatures and a temperature may finally be reached where the coal is afire.

Rate of oxidation in most coals increases only very slowly with the temperature up to about 150 deg. F. When the temperature rises above this, the pile should be carefully watched. A temperature of 150 deg. F. represents the danger point for many coals. If conditions for oxidation are particularly favorable and conditions for heat dissipation are poor, the temperature rises above this point, and more rapid oxidation occurs with still further increase in temperature until finally the kindling point of the coal is reached. For most bituminous coals, the kindling temperature is above 300 deg. F.

Heating of stored coal can be stopped by water, but only if the water reaches the point where heating occurs, for the water can do little good if the stream is played only on the surface of the coal pile. Most bituminous coal cokes on heating, and a shell of tarry material forms about the hot spot, which prevents the water reaching it. Generally, it is better to move the coal and not depend on water. If the coal pile starts to heat, the first rule to observe is: Do not spray water on the pile.

In case the coal is so placed that it is possible to flood it and submerge it in water, this should be done and the coal left under water until needed. The soaking will not hurt the coal. In fact, underwater storage is highly recommended if the facilities are available.

Some plants have been able to extinguish fires in coal piles with water by driving a pipe to the center of the hot spot and attaching a hose delivering water at high pressure. This has the objection that the water may spread through the coal and cause hot spots elsewhere.

There are two methods of stopping heating or burning in piles which do not involve the use of water. One, as mentioned before, is sealing with asphalt, fine coal, or even limestone dust. If a good seal is obtained in the first place and kept, it will prevent heating or stop it if it has started. The other method is to move the hot coal.

The U. S. Bureau of Mines reports that three-fourths of the coal fires studied have occurred within 90 da. after the coal was placed in storage. Therefore, temperature checks should be made periodically and early after storage so that the hot spots, if any, can be found and moved before damage is done. In this case the small amount of hot coal is usually sent to the boiler room. The temperature of all coal piles should, however, be continuously checked periodically just as an insurance against trouble.

Tendency to heat in storage varies with bituminous coals. Coals of the lignite, sub-bituminous, and bituminous B classification are subject to more rapid spontaneous heating processes than the higher-rank bituminous A coals. Therefore, in storing large quantities of such coal, the Bureau of Mines recommends that information on the coal be obtained locally.

For this reason it is very important then to properly select the coal to be stored. For the smaller plant where only a relatively small amount of coal will be stored, it is more logical to select coals which are not likely to fire if stored reasonably well than to use a coal which requires very careful storing. Perhaps a large utility with a great deal of storage capacity and the necessary equipment can safely store lower-grade coals.

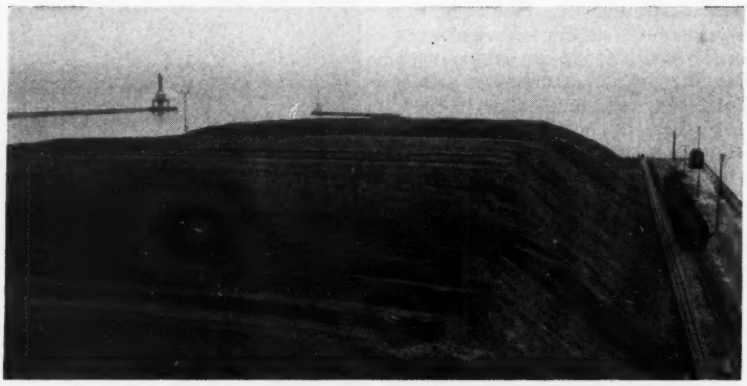
An objection often voiced to the storing of coal is the heat loss. The loss in heating value, measured in B.t.u.'s, due to oxidation while in storage, does not amount to a very great percentage of the original heating value of the coal. It is so small that it can be disregarded, particularly at the present time. The possible loss is much less than would occur if production were halted or plants forced to go without heat because coal was not stored.

Some changes in burning characteristics may occur in storage. It is of importance primarily for slack-size coals. For example, the caking tendencies of the coal may decrease appreciably. Whether or not the decrease in caking or coking tendencies affects the efficiency of the fuel-burning equipment depends upon its type. For example, such coal would not burn nearly so satisfactorily on a hand-fired downdraft furnace; after being stored for many months it would not stay on the upper grates as well. Change in caking characteristics is likely to benefit rather than harm the coal for use on stokers.

The extent of slacking of coal in storage depends principally on the rank of the coal. The lower-rank coals, such as lignite, sub-bituminous coals, and high-inherent moisture bituminous B coals, slack from weathering much more readily than the higher-rank coals. The slacking, under good storage conditions ordinarily extends only a short distance into the coal from its exposed surface. Very little difficulty, if any, from slacking should be experienced with the higher-ranking bituminous A coals.

All sizes of coal can be stored, but in general the less spread between the top and bottom size, the less trouble in storage. Run-of-mine, for example, may cause trouble, if not properly handled, because it tends to segregate.

Sizes of coal commonly used in industrial plants that is, nut and slack, require more care than the domestic sizes. Pulverizer coal ⅜ in. by 0 in. or ¼ in. by 0 in., usually stores as well as other slack sizes, although there may be some loss due to the wind blowing the fine coal away. For long-term storage in exposed places, this coal may be covered with a layer of 2-in. nut and slack to reduce this loss.



Careful piling, packing, and fireproofing a storage pile on the Port Washington coal dock. This shows a nearly-completed 200,000 ton pile in the foreground being carefully piled and tractor packed to reduce heating and to give maximum storage. Furrows in the forward (top) were caused by removal for plant usage. The pile in the background is the 6 yr. old 80,000 t. fire-proofed one shown in Fig. 1 on the opposite page

Summary

Summing up the problem of coal storage, especially for small industrial plants, the points to be kept in mind are:

1. Proper selection of the site for the storage of coal.
2. Careful preparation of the storage site.
3. Consideration of the types of coal available for storage, giving preference to those coals that are less liable to fire.
4. Careful stocking of the coal in horizontal layers, preventing segregation.
5. Checking of the coal storage pile at regular intervals by thermometers or other means.

If these few simple rules are observed, there should be no loss nor danger incurred in storing coal and the continuity of plant operation will be assured. In the event the stock pile does start to heat, however, the above suggestions which we have offered on what to do in case of heating, should be put into effect.

STORING COAL SAFELY

Packing, asphalting, sealing with fine coal, detection of heating, rain and with erosion prevention, and thermal losses during storage piles are treated. Experiences at the Port Washington Power Plant and conclusions derived from piles stored from a few months to 6 yr. Air flow resistance through coal. Effect of coal size and type and wind velocity on height of coal piles. Storing hot coal. Fire proofing strategy and economics. Effect of sulphur and water. Repiling and danger spots apt to cause trouble

by M. K. Drewry, Asst. Ch. Eng. of Power Plants, Wisconsin Electric Power Co., Milwaukee, Wisc.

PERENNIAL coal storage troubles reached a peak in 1933 when a 120,000 t. pile (See Fig. 1) had to await delayed operation of the then new Port Washington Plant until late in 1935. All previous troubles, thought serious enough, paled in the light of the new problem.

In spite of packing the mine-run coal to 18 per cent greater density than in an unpacked pile, it heated to 800 deg. F. at one point within 5 mo. Obviously, something had to be done, for experience indicated that when 150 deg. F. is exceeded, there is little chance of preventing fire unless something effective can be done to arrest the upward trend.

Making the top of the pile airtight to prevent "stack-effect" inducing air flow, and thus limiting heating, had no effect in reducing the trouble. Not until the sides of the pile were sealed with asphalt during late 1933 was the upward temperature trend turned downwardly. The serious threat was removed, and all temperatures gradually sank downwardly. In 3 yr. the pile was removed with a heat loss of 4.15, or 1.4 per cent per yr. Other data of the pile are recorded in Table I under pile No. 1.

'Bleeding' of the 'cut-back' asphalt used to seal this pile caused the need of repair, and indirectly suggested that very fine coal, approaching the fineness of pulverized coal, was as effective as asphalt in sealing. Laboratory tests evaluating the relative resistance to air flow of various sized coals proved that a few inches of minus 48 mesh coal afforded a great deal more resistance to air flow through a pile than packing all of the coal; in fact, they disclosed that this fine coal was practically impervious to air flow when moistened and slightly packed. Table II affords data of coal sizes and resistances to air flow.

A New Concept of Air Flow Through Coal Piles

These laboratory tests afforded a new quantitative conception of air flow through coal. Note that moderate packing doubles resistance; that hard packing at screenings simply quadruples resistance.

Fig. 1. Port Washington coal dock where a 422 ft. span of the coal bridge permits large piles that are economically fire-proofed. Extensive temperature data show that exposure to winds has been the greatest cause of spontaneous heating. A 6-yr. old fire-proofed pile still occupies the outer end of this dock

Table I. Eight years of coal storage experience at Port Washington showing relative data of fire-proofed and unfire-proofed piles. Pile No. 3, now 6 yr. old (See Figs. 1 and 2), could apparently be kept indefinitely without heating trouble. In this data, weights, as stored, are those of shipping association; as removed, are car weights on platform scales, used to determine station heat consumption

PILE NO.	1	2	3	4	5	6	7	8	9	10	11
Stored in	1933	1935	1936	1936	1937	1937	1937	1938	1938	1939	1940
Removed in	1936	1936		1936	1937	1938	1937	1938	1939	1940	1941
Fireproofed?	Yes	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes
Weight, 1000 t. stored	124.2	45.7	79.9	73.1	43.0	83.0	40.2	72.9	108.9	224.6	166.5
1000 t. removed	122.4	46.6		73.8	43.2	84.2	40.7	73.8	110.4	227.2	169.0
per cent change	—1.42	+2.06		+0.95	+0.43	+1.47	+1.41	+1.21	+1.38	+1.17	+1.54
Moisture, % as stored	2.08	3.23	3.12	3.48	3.23	3.44	3.39	3.26	3.8	3.8	3.55
% as removed	3.2	4.36		4.31	3.73	3.63	4.27	4.44	4.3	4.4	4.44
% increase	+1.12	+1.13		+0.83	+0.50	+0.19	+0.88	+1.18	+0.47	+0.61	+0.89
Volatile matter, % as stored	38.4	36.2	34.8	34.6	36.0	35.3	34.7	34.4	34.9	34.9	34.96
Fixed carbon, % (dry) as stored	53.2	55.1	56.1	55.5	54.7	55.6	55.3	56.3	55.9	56.3	56.37
Ash, % (dry) as stored	8.4	8.7	9.1	9.9	9.3	9.1	10.0	9.3	9.2	8.8	8.67
Sulphur, %	2.85	2.27	1.62	2.05	2.39	1.75	1.63	1.30	1.58	1.37	1.13
B.t.u./lb. dry, as stored	13840	13841	13740	13670	13618	13635	13545	13684	13687	13676	13726
as removed	13610	13587		13497	13522	13590	13599	13669	13536	13658	13586
% change	—1.66	—1.84		—1.27	—0.70	—0.33	+0.40	—0.11	—1.10	—0.13	—1.02
B.t.u./lb. as received, as stored	13552	13394	13314	13195	13179	13167	13087	13238	13166	13158	13243
as removed	13176	12995		12916	13017	13097	13018	13063	12955	13056	12983
% change.	—2.77	—1.64		—2.11	—1.23	—0.53	—0.53	—1.32	—1.60	—0.78	—1.96
Ash Fusion Temp., deg. F.	2205	2250	2377	2297	2264	2280	2227	2283	2300	2304	2376
Total B.t.u. $\times 10^{12}$, as stored	3.365	1.224	1.064	1.928	1.133	2.185	1.052	1.929	2.868	5.910	4.409
as removed.	3.225	1.212		1.906	1.112	2.205	1.061	1.927	2.860	5.933	4.389
% change.	—4.15	—0.99		—1.18	—0.81	+0.93	+0.86	—0.13	—0.26	+0.39	—0.45

Ave. yearly loss of five fire-proofed piles, (14 mo. ave. storage) = 0.1%. Ave. yearly loss of five unfire-proofed piles, (4½ mo. ave. storage) = 0.9%.

It does not stop air flow entirely, as may be thought. It results in only two-thirds the resistance of $\frac{5}{16}$ in. carbon, loose, which latter coal has fired spontaneously. The data allowed calculation of relative air flows through piles with various degrees of packing and of various coal size compositions. They largely removed the element of chance and experimentation attendant with previous coal storage efforts.

The next large pile, a 40,000 t. one on a Milwaukee dock, was 'fire-proofed' with a foot of minus 48 mesh coal (the relatively inexpensive by-product of a dedusting process), covered with another foot of coarse coal to avoid rain and wind erosion. It was eminently successful, requiring little maintenance and costing a total of 2/3 per cent of the coal (asphalting had cost 1 per cent). Heat loss was less than B.t.u. measurement accuracy, for a 1/10 per cent gain was measured.

An 80,000 t. pile for semi-permanent storage, fire-proofed with minus 48 mesh coal in 1936, is still intact on the Port Washington dock. Figure 2 shows that it slowly heated in 2½ yr. to 150 deg. F., due to minor air leaks, and then cooled in 3½ yr. to the present level of 122 deg. F. after a total of 6 yr. of storage. Because of the downward temperature trend, apparently the pile can be kept without trouble, indefinitely.

Routine Fireproofing

Based on these experiences, one of the two 75,000 t. piles used at Port Washington each year (the one piled first and used last) was fire-proofed with minus 48 mesh coal. The other pile deliberately stored late in the navigation season and used immediately, required no fire-proofing because of its relatively few months of storage.

Routine fire-proofing with fine-coal covering was used 5 yr. with varying degrees of good success. More frequently than not, compromises in its application were necessary because shipments of storage and fire-proofing coal were not controlled for best fire-proofing. Change in coal purchase plans often required incomplete fire-proofing. Never, however, was the majority of the coal hotter than to the point of simply being dusty and steaming.

Experience during these years of fire-proofing confirmed that air leaks in a covered pile always betray themselves with a characteristic tell-tale vapor discharge. Thus, observation during early morning, on a day of high humidity, or on a cold day, discloses every air leak. Patching all such leakage areas with fine coal definitely assures an air-tight pile, thus affording assurance against heating.

This ability to detect and stop air leaks seems a vital principle insuring freedom from undue heating. From an 'unfire-proofed' pile, these streamers of vapor usually mean a fire eventually unless the coal is soon removed; in a 'fire-proofed' pile they simply tell of a leak that if stopped will insure decrease of coal temperatures.

Packing Again Used

Increasing coal storage and plant capacity later urged taking advantage of the extra storage capacity afforded by packing. The recent year of experience with packing shows favorable results for 9 mo. storage of screenings.

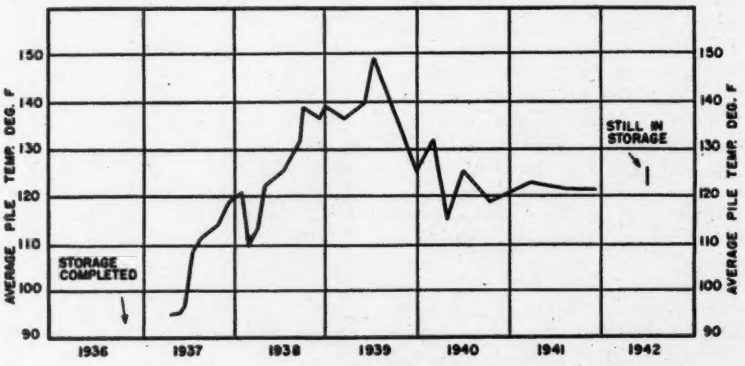


Fig. 2. Temperatures during 6 yr. storage of an 80,000 t. coal pile. In 2½ yr. temperatures rose to 150 deg. F. average and then slowly declined in 3½ yr. to the present 122 deg. F. average. Apparently this pile can be kept indefinitely

Packing has been more thorough than with the original pile of mine-run coal that required asphalting, and sizing of the coal is undoubtedly also an important benefit. Other piles on the dock, in reducing wind effects, have also slowed the heating rate. Recent removal (May, 1942) shows minor heating, but suggests that several years' storage would be questionable. Packing appears best adapted to one-season storage, and pays its own way when limited storage space exists.

Packing Principles—Starting with the Horse and Buggy Days

It is understood that the value of packing coal was first realized by the Philadelphia Electric Co. when observation, over a period of years back in the 'horse and buggy days,' showed that storage by horse-drawn wagons travelling onto the pile never resulted in fires. Conversely, the same coal stored without such treatment heated spontaneously. That the more uniform piling afforded by the wagon method may have been as important as the packing seems possible, for obviously, air flow resistance is dependent upon the degree of segregation of various sizes as well as the distance between particles.

Obviously, if screenings are further screened and the various sizes piled individually in a common pile and packed without crushing, average air flow resistance would be little. True, little air would penetrate the dust-sized section, but adjacent lumps, even relatively small ones (say ¼ in. for instance), would readily pass air and would allow spontaneous heating that would conceivably spread throughout the pile.

That the packing aspect is less important than preventing segregation of sizes is indicated by experience, tests, and theory. So-called packing always requires depositing coal in layers, thus reducing or entirely preventing segregation resulting from cascading down the sides of sloping piles. Further, spreading in layers prevents perpetuation of segregation from previous handling, for it in effect remixes the coal.

Aside from effects of crushing, tractor packing does not compress the bottom of a coal pile appreciably more than does the weight of coal above it. A typical caterpillar tractor used for packing created an average pressure under the 'cats' of 9.1 psi. (25,306 lb. on 2775 sq. in.), which is equivalent to about 24 ft. depth of coal.

Value of Careful Piling

Further, it is obvious that only the top few inches of coal under the tractor receives this pressure, for at lower levels the tractor weight is carried over a wider area. Larger tractors exert no more pressure force, for usually the unit pressure is kept constant regardless of tractor size, so that all sizes can travel on equally soft ground. Of course large tractors can pack more coal per hour.

Experience this recent season indicated the value of 'layer' piling. Two large piles stocked that way, on the docks of Milwaukee coal companies, heated less, representatives of each company concluded, than did piles made without regard to size segregation. The piles received no attention other than layer piling. Part of this coal is still in place after 1 yr. storage. No rehandling was necessary, but, of course, the piles could not have been kept indefinitely like fire-proofed ones. Reclaiming was first practiced from areas showing 'steaming,' which were usually at the corners and ridge lines where the top and sides met.

Small sections of localized segregations of various sized particles throughout a pile, though not as undesirable as large sections of segregated sizes, decrease the total resistance to air flow greatly below that of uniform mixtures. In other words, 'coning' of small piles or segregation in small ridges should be avoided. As in best concrete aggregate, sizings at all points should be such that most voids are filled. To obtain this, no coal should cascade down a slope, even a short one, but ought to stay where placed.

Insulating effect of coal is obviously an important element of its self-heating. A lump of coal in warm air undoubtedly generates more heat than during the first stages of spontaneous heating of a pile, yet it does not rise perceptibly in temperature. But insulate it thoroughly and supply the right amount of air, and it will become hotter and hotter. Chemists point out that most chemical reactions double with approximately each 20 deg. F. rise in temperature. Thus, since the heating rate would be 16 times faster at 150 than at 70 deg. F., the vital role of coal's insulative value is realized. Coal insulation of small piles is relatively thin; of large piles the central portion is almost perfectly insulated.

Pile height seems most important in relation to wind effects, for air flow caused by winds is greatly more than that caused by so-called 'stack-effect.' Exposure to winds seems therefore more important than pile height.

Table II. Coal fineness and air flow resistance data for various types and sizes

	PER CENT THROUGH, MESH								
	200	100	48	28	20	10	6	3	½"
Pocohontas screenings	3.2	4.4	6.4	10.4	12.6	25.4	47.8	80.6	98.6
Kentucky screenings	6.2	9.4	14.8	21.6	26.8	38.4	51.8	70.0	92.6
Illinois 5/16 in. carbon	4.6	7.9	13.6	22.0	28.8	47.2	76.0	88.0	100
Illinois minus 48 mesh	36.4	48.8	69.5	85.8	93.6	99.0			

	VELOCITY, FT. PER SEC.		
	0.01	0.1	1.0
Pocohontas, crushed		.01	.13
Pocohontas, screenings		.035	.40
Kentucky screenings, loose, wet		.04	.50
Kentucky screenings, loose, dry		.05	.9
Kentucky screenings, moderately packed, wet		.12	1.6
Kentucky screenings, hard packed, wet		.15	2.1
Kentucky screenings, hard packed, dry		.17	3.4
Illinois 5/16 in. carbon, loose		.24	4.2
Illinois, minus 48-mesh, loose	.7	6.0	45.
Illinois, minus 48-mesh, 100 lb./sq. ft. loading	.9	7.5	
Illinois, minus 48-mesh, 150 lb./sq. ft. loading	1.1	9.0	
Illinois, minus 48-mesh, wet, packed	practically air tight		

Since the ratio of surface area to tonnage is least for large piles, fire-proofing methods involving coverings are more economical for large piles than for small ones. Also, since the per ton cost of packing or careful piling is not influenced appreciably by pile size, it has an advantage for small piles. Which method is more economical, more effective, and more practical, must necessarily be determined for each case.

Fire-Proofing Strategy

If packing or careful piling is so planned that covering can be added later, if required, no more expenditure need be made than developments prove necessary.

Proceeding on this basis seems most generally applicable where experience has not been had with coal storage.

Knowing with certainty that covering the external surface of a pile with asphalt or fine coal will positively stop heating, is sometimes worth a great deal. Without this knowledge, storage often cannot be considered in spite of high desirability, for chances of serious trouble cannot be taken by most industrial organizations. Often there is no room to repile a heated pile (this is understood to be helpful, though a single experience indicates otherwise), nor can the heated coal be used as rapidly as it heats to the firing point. Surface coatings are then invaluable. They are as well appreciated as a fire-extinguisher in an emergency.

Choice of Coal for Storage

Lump coal, or semi-pulverized coal, does not ordinarily heat spontaneously. Either too high or too low air flow prevents temperature rise. Only when heat generation exceeds heat dissipation does temperature rise.

To reliably determine heating probabilities for borderline cases is, of course, impossible. Other things being equal, choosing coal as near the non-heating size, or with best sizing characteristics (best filling of voids) is desirable.

Since sulphur and water are the 'torch' that heat the coal initially to about 150 deg. F., at which the oxidation process becomes important, their quantity in storage coal is important. Incidentally, the ineffectiveness of putting water onto heating coal is realized when the role of sulphur and water are understood.

Though oxidation rate normally increases with fineness, the effect of lesser air flow through fine coal actually lessens oxidation. Choice of moderately coarse screenings for instance, with the hope that air flow will be adequate to prevent heating, is not as conservative as choice of fine screenings. Segregation in the first case can cause local heating that will rapidly spread throughout the pile because of liberal oxygen supply. In the case of fine screenings, low air flow limits heating rate throughout the pile.

Specifications for storage coal might well limit coal temperatures upon receipt. If it is true that the coal heating rate doubles with each 20 deg. F. higher temperature, the coal temperature when it is being stored may well determine whether or not it will 'fire.' Oftentimes partial shipments of very hot coal are received, and these may readily be the immediate cause of heating trouble. If they must be stored, thin spreading on an external surface where heat dissipation is most rapid is much better than trying to bury them, unless, of course, the pile is to be fire-proofed with an air-tight seal.

Heat Loss During Storage

Table I proves that heat loss is negligible if heating is avoided. Though it includes data of a pile that heated appreciably, it shows only 0.1 per cent loss per year for five piles stored an average of 14 mo.

Large piles that are not fireproofed, and have a tendency to heat spontaneously, can be kept about 6 to 12 mo. without excessive loss. Table III shows five piles stored an average of 4½ mo. with an annual loss rate of 0.9 per cent per yr.

Conclusions

Coal can be stored for many years with negligible heat loss and without fire trouble if air ventilation is stopped by external airtight coverings.

Careful piling or packing normally permits storage in large piles at least for a year without trouble. In smaller piles, longer storage is practical.

Careful piling consists of preventing segregation throughout a pile. For maximum resistance to air flow, every cubic foot of the coal ought to have its coarse and fine particles well mixed.

Packing causes careful piling besides slight crushing, and affords about 20 per cent more storage in a given space.

Careful piling or packing, followed by air-tight covering if and when need for the latter occurs, seems the most practical procedure in most cases.

Pittsburgh Coal Co., Photo

A combination picking table and shaker screen in a modern coal tipple

FOR the LARGE PLANT

Summary of experience over a period of years in developing storage methods and practices to prevent fires and reduce loss from handling and weathering. Ground preparation and drainage is important and cinder fills are used extensively. Visual means and thermocouple readings to check on internal heating are used extensively, but a gas instrument has been developed as a more rapid method. Compacted layer storage with bulldozers, used in connection with a variety of handling equipment, has eliminated undue heating and such piles are no longer checked. Pile size is influenced by limitations other than heating. Crowning and sloping of piles is important to prevent entrance of air and excessive gullying of the pile by rain. Method of reclaiming should be considered and size degradation is sometimes important. Experimental investigation being made on compacting new coal against old to determine danger spots

by Raymond J. Brandon, ***Production Department, The Detroit Edison Co., Detroit, Mich.***

PROPER STORAGE of coal at The Detroit Edison Co. coal sites has been of increasing importance since water-borne coal was first delivered at Marysville Power House in 1926. Since that time equipment for handling water-borne coal has been constructed at the other plants and usually about 5 mo. coal supply is stored to meet the coal demand during the closed navigation season. The increased coal consumption, due to the growth in system load, has necessitated an ever-increasing quantity of coal to be stored, and it is expected that over 1,000,000 t. will be in storage at the close of the navigation season this year.

When relatively small quantities of coal were stored, fires due to spontaneous combustion occurred regularly, but with a small number of piles it was possible to remove the hot coal before any fires reached serious proportions. As the quantity to be stocked and the number of piles increased, it was necessary to reduce the fires caused by spontaneous combustion to an absolute minimum or serious trouble would be encountered.

A more active interest in stocking coal revealed that there were various factors that contributed to spontaneous combustion and although fires were not completely eliminated until compacting of coal was started, the number occurring was reduced considerably. Some of the contributing causes, as gained from our experience over a number of years, are described in this article under separate headings.

Coal Site

Coal stored in some areas of the coal site seemed to be more susceptible to spontaneous combustion and fires occurred regularly in these places. It was noted in most cases that drainage of moisture from these areas was poor with the ground below the pile being wet most of the time. After removing coal from these areas, cinder fill was brought in and the area filled to a grade to insure proper drainage. In some cases it was necessary to install drain tile.

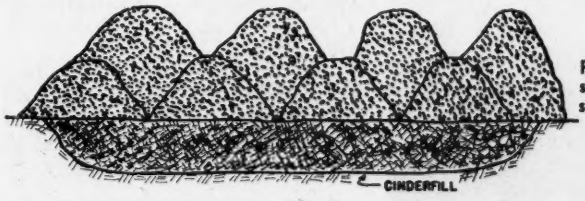


Fig. 1. Method of storing coal by clamshell in piles to avoid segregation

Results were sufficiently favorable to warrant filling all areas where coal was to be stored with about 1 ft. of cinders, and this practice is followed at the present time. Although the use of cinders may allow some air to circulate at the bottom of the pile, the need for proper drainage was considered more important.

Reduction in the number of fires resulting from proper preparation of the site has well warranted the additional time and expense incurred. Where present available space must be used, it would be well to guard against storing coal near steam lines or other external heat sources as this condition is very conducive to starting fires.

Coal Segregation and Dimension of Piles

Importance of avoiding size segregation of coal when it is being stored cannot be too strongly emphasized. This condition probably contributes more to the spontaneous combustion of coal to oxidize the coal and support combustion. To avoid segregation as much as possible, coal was stocked as illustrated in Fig. 1. This reduced the size segregation in the lower part of the pile, but could not be avoided as the pile increased in height.

As coal was loaded to storage by locomotive cranes it was necessary to lower the bucket to place the coal in its proper location. Since more time was required and it was a tedious operation, it is doubtful if all coal was laid down in this manner. However, more care was taken in loading the coal to storage to avoid segregation and it probably was a contributing factor in reducing the occurrence of fires. The practice of building part of the coal pile to its finished height and then adding to it, is to be avoided if possible.

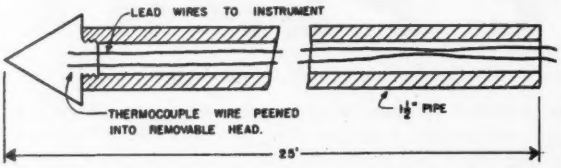


Fig. 2. Detail of thermocouple and pipe probe for exploring coal pile for danger spots

With this method of storage the larger lumps collect where the piles join and provide an easy path for air circulation. Because of track curvature at some places where coal was to be stored, it was necessary to build the coal pile in two sections. More fires occurred at places where coal was stored in this manner than any other place in the yard.

Experience in storing coal at different heights indicated that to store as much coal as possible in a given area, and still attempt to keep the number of fires to a minimum, the height of the pile should not exceed 25 ft. The width of the pile depends to a great extent on the equipment used for storing, and in our case the locomotive crane boom length dictated that track centers be 90 ft. apart.

This resulted in the width of the pile being about 80 ft. at the base. The coal piles were built up to their final height over the continuous length of the pile so that size segregation, as mentioned previously, would be reduced as much as possible. The length of the coal piles varied from 300 to 1200 ft. and approximately 20,000 t. can be stored in an area of 60,000 sq. ft.

Methods of Detecting Heat

The necessity of using some method of determining the areas in which heat was developing has been clearly demonstrated since coal was first stored. By keeping a close watch on places that showed signs of heating, it was possible in most cases to remove the coal before any serious fires occurred. The method used in locating hot spots is dependent again to a great extent on the quantity of coal being stored.

Probably no method used has been as valuable in detecting heating as a daily inspection of the coal piles. By having a man walk along the top of the piles many hot spots have been found that might have been missed when checking with instruments. The appearance of the coal pile under different weather conditions in many cases indicates the area developing heat.

After a heavy rain, the appearance of the coal in a hot area is readily discernible since the coal in this place dries out and appears much lighter in color than the surrounding coal. When the pile is covered with snow, the places where the snow melts first clearly indicate the warm areas. In cold weather, vapor continually issuing from certain locations usually shows heating in that section.

Odor of gas emanating from the pile is usually indicative of heat, but it may be difficult to localize the point where it is being given off. After detecting an area that showed signs of heating, checks were made by either thermocouple temperature measurements or gas sampling to determine the rate at which heat was being developed.

Table I. Temperature records of a coal pile, stored May 29, 1935, taken at various depths from the surface of the pile. Temperature readings are in degrees Fahrenheit

Date	5 ft.	10 ft.	15 ft.	20 ft.
6-12-35				No readings
7-11-35				102
8-6-35				118
9-10-35			142	130
10-22-35			133	110
11-5-35	150	135	102	88
12-6-35	200	250	355	95

Temperature readings were taken by means of a portable thermocouple constructed as shown in Fig. 2. This was moved to the various areas that appeared to be heating and forced into the pile to obtain the temperature of the coal at 5 ft. intervals throughout the pile height. The need of taking readings at various heights is illustrated by a typical set of temperature readings recorded in Table I.

The depths as shown heading the temperature reading columns were measured from the top of the coal pile and the removal of coal was started immediately.

Gas Sampling Instrument Speeds Checking

As the quantity of coal to be stocked increased it became difficult to obtain temperature measurements at all the places developing heat since much time was

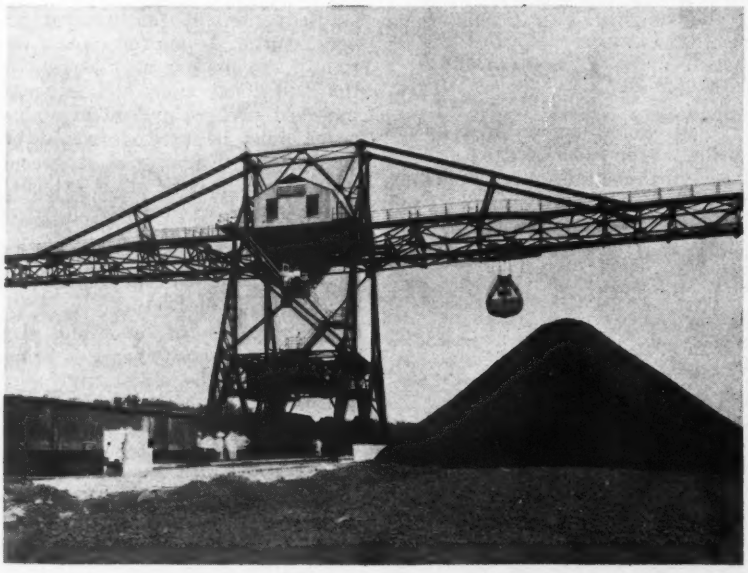


Fig. 3. Handling equipment is determined largely by physical aspects of the property. At this station where a large storage area is available a gantry cantilever travelling crane works in well

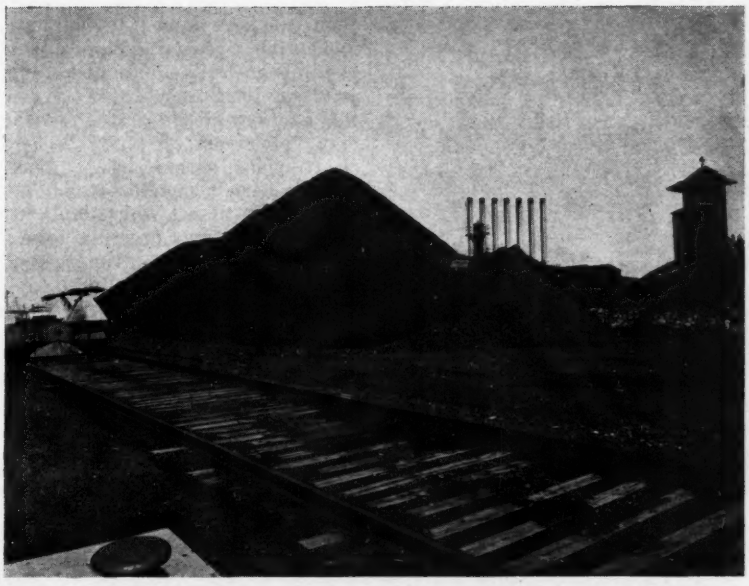


Fig. 4. A drag-line scraper with a movable track mounted tail tower moves coal to storage or reclaims it for use in the plant in this rather restricted storage yard

consumed in moving a thermocouple this side, and it was necessary to leave the thermocouple at each location until it reached the actual temperature of the coal. A new method of detecting heating was introduced, based on the principle of determining the amount of combustible gas emanating from the coal.

The instrument used was an indicating instrument calibrated for methane gas and manufactured by the Mine Safety Appliance Co. The instrument was calibrated so that a scale reading of 100 was obtained when the gas sample contained 5 per cent methane gas. The sampling tube was about 5 ft. long and was usually forced about 4 ft. into the coal pile to obtain a reading.

By means of a bulb aspirator, a sample was drawn into the instrument where the combustible gas was burned and a direct scale reading obtained. Information, concerning the reading actually taken in the field, is limited since it has not been found necessary to check the compacted coal piles for heating, and much of the data previously taken has been destroyed. The data listed in Table II has been included for purely informative purposes and should not be considered a true correlation between gas indications and temperature.

Usually an indication up to 7 or 8 caused no concern, but if readings above this were obtained the location was watched closely and readings were taken more often to determine the progress of heating. This method provided a rapid means of checking a large number of coal piles for indications of heat and was used at all the large coal sites.

There is some question, however, as to just how applicable this method would be for determining the exact location of a hot spot. In our case, we were primarily interested in obtaining a rapid method of checking the piles for heating, and localizing a hot spot within a distance of about 20 ft. along the pile was satisfactory since this amount of coal usually had to be reclaimed to reach the hot coal.

Exploring the area surrounding the place where gas was indicated easily located the hot spot within the required distance, and proved to be easier and faster than exploring with a thermocouple. Where a more definite location of the hot spot is required, so that the minimum amount of coal will be removed, the method may not be suitable and could only be determined by experiment.

Experience in using this method with coals of different rank, size and storage conditions would determine its field of application. For our conditions, it has proved very satisfactory and has been used continually up to the time that compacting of coal was started in 1938.

Oil Coatings and Compacting

Some of the coal piles have been coated with heavy oil after being placed in storage to reduce the amount of dust that may be blown from the pile. As to the value of oil treating or covering the pile with oil to reduce spontaneous combustion, no data are available.

Fig. 5. Storage area served by a locomotive crane. At the time a fire, just to the right of the clamshell bucket, was being dug out. The layer method of storage and compactness has done much to decrease the fire hazard from spontaneous combustion

Fig. 6. Bulldozer being used to store coal by the layer method and compact the coal

Practically all of the large quantities of coal that have been stored in the past 3 yr. by The Detroit Edison Co. have been compacted by means of bulldozers with trail-building equipment. This practice has eliminated all fires due to spontaneous combustion where the coal has been properly packed, and it has not been found necessary to check the compacted piles for indications of heat.

Equipment used for handling coal is an individual problem for any plant, as the land available for storage, the plant location, and other physical aspects of the property are all factors that must be considered when deciding what equipment will be installed. At the Trenton Channel Power House where there is a large storage area available at the dock, a gantry cantilever travelling crane, as illustrated in Fig. 3, is used.

At the other plants, location of the coal-storage site has dictated that drag-line scrapers be used, as illustrated in Fig. 4. movement of coal to storage or to the plant for consumption. The coal is loaded to storage by means of locomotive cranes, as shown in Fig. 5, and is spread and compacted by bulldozers as it is laid down.

Equipment used in compacting the coal is illustrated in Fig. 6, and the weight of the tractor with the trail-building equipment is about 22 t. The coal is dropped from the bucket with no attempt to avoid segregation since the spreading and compacting of the coal fills the voids and stops air circulation through the pile.

Coal is compacted in layers varying in thickness from 1 to 2 ft. with the latter thickness about the maximum if trouble due to heating is to be avoided. Depending on the amount of rolling and the thickness of the layers, the average density of the coal may vary from 58 to 66 lb. per cu. ft. This increase in coal density has been a decided benefit at some of the plants where land for storage is at a premium since about 20 to 25 per cent more coal can be stored in a given area.

Another factor in increasing the storage capacity using bulldozers has been the possibility of increasing the width of the piles, and the use of locomotive cranes for loading coal from cars to and from storage has proved very flexible in experimenting with coal piles of different widths, since the tracks can be easily moved. Previously track centers between coal piles could not be greater than 90 ft. since it was necessary for the crane boom to reach the center of the pile.

With compacting of the coal this is not a determining factor since coal can be moved to the center of the pile by the bulldozers. Experiments in increasing the width of compacted piles have not as yet determined the optimum width since other factors such as the width of the site and the availability of land for storage may necessitate piles with widths that are planned for maximum storage, rather than for ideal working conditions for the compacting equipment.

Increasing the base width of the piles has required, in most cases, increased height so that the pile can be properly crowned to provide drainage and reduce the amount of moisture absorbed by

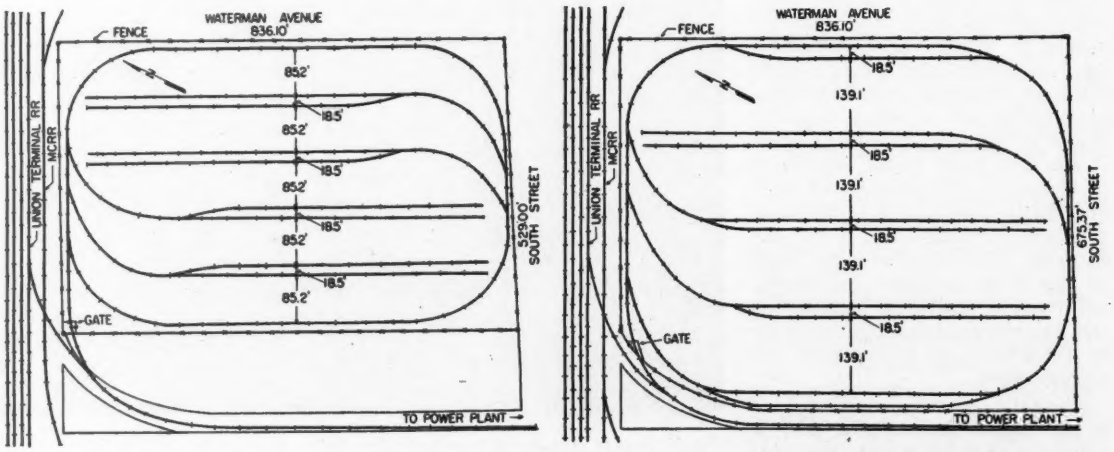


Fig. 7. On the left the original track layout of a coal site and on the right the revised layout designed to give greater capacity. Originally the pile width was limited by the crane boom. Supplementary use of a bulldozer for handling makes possible a wider pile

the coal. Where storage space is not at a premium, the original pile widths have been retained, but at other areas the width may vary from 117 to 155 ft. The original and revised track layout for one of the coal sites is shown in Fig. 7.

Where the coal piles have been increased in width and height to obtain more storage, it has been necessary in most cases to move coal about 175 ft. by means of the bulldozer. The coal piles are usually built up to the final height continuously along the entire length of the pile, but some piles have been built in sections along the length to determine if less moisture is collected by the coal when less of the coal area is continually exposed to rainfall. As yet no data is available as to the benefits of stocking in this manner.

More coal must be moved by the bulldozer when it is desirable to increase the height of the pile above the height limited by the length of the crane boom. Where storage space is at a premium this has been done successfully, but more time is required to stock the coal, and more care must be exercised to insure that the coal is properly packed. In increasing the height of the pile it must be remembered that the bearing strength of the ground is a factor that must be considered, or ground movement may cause considerable damage.

Crowning for Drainage

Experience with compacted coal piles has shown the necessity for proper crowning and top dressing of the pile to insure proper drainage of moisture. If the top of the pile is not fairly level, large quantities of water may run off the pile at one place, resulting in deep gulleys and considerable washing of coal from the sides of the pile. This condition is illustrated fairly well in photograph designated Fig. 8. The crown of the pile should be fairly well defined so that adequate drainage is insured.

One of the first compacted piles was built with a base width of 175 ft. and a height of about 30 ft. at the center. Due to the bearing strength of the ground, the end section of the pile was only built up to a height of about 12 ft. and not crowned. The moisture content of the coal removed from this section was about 2 per cent higher than usually obtained, and, coal removed from the main section of the pile also contained too much moisture.

Fig. 8. Proper crowning and slope dressing is necessary if gulleys like this are to be avoided

A cross section of the coal pile as stored in this area at the present time is shown in Fig. 9, and the pile appears to be crowned sufficiently to provide proper drainage. If necessary it would be advisable to top dress the pile manually to insure that water will not collect in pools and drain into the pile.

Due to the need of increased storage at one of the coal sites, coal is being stored and compacted against a pile that has been in storage about a year. It will be an interesting development to see if coal can be stored in this manner and compacted sufficiently so that heating will not occur.

Practically all the coal stored is 2-in. nut and slack from West Virginia and East Kentucky. The coal is designated as high volatile Bituminous-B according to the A.S.T.M. classification by rank, and no experience has been had with storage of other coals. No data are available as to the deterioration from slacking or breaking of the coal since size degradation is not too serious a factor with the type of fuel-burning equipment used.

Table II. Gas instrument readings compared with temperature readings. The data is purely informative and should not be considered a true correlation between the two. In practice, gas instrument readings above 8 are immediately investigated

Scale Reading	Thermocouple Temp. Readings, Deg. F.			
	5 ft.	10 ft.	15 ft.	20 ft.
6	155	165	160	147
11	180	177	170	150
70	173	170	195	349

Use of Emergency Equipment

Individual conditions to a great extent will dictate the equipment that is required to store coal, but in some cases it may be possible to use the compacting equipment to move coal for short distances. With the curtailment of private building, many bulldozers that were used around this type of construction may be available and could be hired during the storing period so that a large investment in coal-handling equipment would not be required. It must be remembered however, that when the coal is reclaimed the bulldozer will have to be used to loosen the coal so that it can be handled.

Where size degradation is a pertinent factor it does not seem that coal could be economically stored by compacting due to the breaking that would occur. If compacting the coal is not feasible, it appears that either the coal should be stored to provide sufficient air circulation to remove the heat as it develops or reduce to a minimum the circulation of air which supplys the oxygen for combustion.

Valuable experience should be gained concerning the benefit of compacting coal of different ranks and size if much coal is stored by this method during this emergency period. It will be an interesting development to see how much spreading and compacting is required and what types of equipment may be used advantageously with low investment.

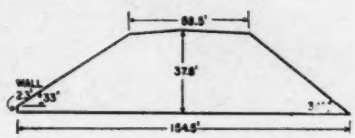


Fig. 9. Cross section of coal pile showing side slopes and crowning used for drainage

SIZING and PREPARATION

Coal size selection as influenced by equipment and use; size and preparation as a factor in coal costs; common names and dimensions of bituminous coal, anthracite coal and coke; size classes; a simplified size system offered as a rational solution of the present chaotic condition in the bituminous field; coal washing; picking, oiling, dedusting and coloring and probable influence of war conditions on coal availability

by Joseph Harrington, Advisory Engineer, Northern Illinois Coal Corp., Chicago, Ill.

FITTING the coal to the firing equipment is as important in combustion engineering as fitting the shoe to the foot is in the army. However, during wartime other considerations such as storage and handling facilities and availability, as influenced by production, Government regulations or transportation facilities may well force a compromise with the use of a coal size and price range most desirable under normal conditions.

Size of course plays an important part in selecting coal for any service. While definite limits cannot be set, in a general way size limitations as determined by firing equipment may be stated as follows:

For natural draft chain grate stokers, ¾ to 1¼ in. screenings are preferred. With forced-blast traveling grates, designed for selective air application, the finer sizes even down to breeze or carbon are suitable, but the top size is 1½ in. With any of the larger sizes, there should be fines enough to fill the voids. Pea or nut sizes can be used if care is used in draft control and if the ignition effect is adequate.

Spreader type of stokers now being built in very long sizes, up to 16 ft., call for a top size coal of 1¼ in. For stokers 12 to 14 ft. long, the top size should be not less than 1 in. On all lengths, fines are desirable in order to get suspension burning. Care must be exercised, however, in high capacity jobs, not to have the percentage of fines too high if the flyash emission is to be kept down.

Coal for Pulverizers

Multiple retort underfeed stokers will take coal of almost any size under 2 in. The domestic screw underfeed calls for a top size of 1¼ in. and a bottom size of ¼ in.

For pulverization, the finer sizes are not always to be preferred. These sizes almost always carry a lot of moisture, which makes it slow to flow out of bunkers or through pipes, and tends to plug up the pulverizer even though very hot gas or air is used in the pulverizer for drying. On the other hand it is wasteful to ship fine coal when dry on account of the blowage and leakage losses from cars.

Pulverizers of the impact type actually prefer nut coals, especially if of the brittle type. Moisture is less and the shattering effect of the impact of the blades is more pronounced. Fairly dry, ¾ to 1¼ in., screenings are generally acceptable for pulverization.

Coal sizing is of course the principal element of what we call preparation, although of recent years preparation has been greatly broadened to include such things as washing, picking, oiling, dedusting and

At the left, loading coal in 50 t. trucks for delivery to the tipple for screening and cleaning at an Indiana strip mine. After the overburden is stripped (right) the exposed coal seam is drilled and broken up with explosives to facilitate loading.

Table I. For bituminous coals, some 32 size groups are available and in more or less common use. Prices are official mine prices for shipment to the Chicago area and indicate effect of coal size and preparation on price

SIZE CLASS No.	SIZE Through and on	PRICE $/ton
1	Lump	1.95
2	8x4 in.	1.90
3	6x3 in.	1.85
4	8 (or 6)x2 in.	1.75
5	4 (or 3)x2 in.	1.70
6	8 (or 8)x1½ in.	1.65
7	8 or 6 in., Mine Run	1.55
8	2x1½ in. Nut	1.60
	RAW	
9	2x⅜ (or ⅛) in.	1.50
10	1½x1 (or ¾) in.	1.45
11	1½ (or 1)x⅜ (or ⅛) in.	1.45
12	¾x8 Mesh	1.45
13	2 in. Screenings	1.25
14	1½ or 1 in. Screenings	1.15
15	Carbon	0.60
16	10 Mesh	0.30
	WASHED	
17	2x⅜ in. or 8 Mesh	1.60
18	1½x1 (or ¾) in.	1.55
19	1½ (or 1)x⅜ (or ⅛) in.	1.55
20	¾x⅜ (or ⅛) in.	1.55
21	2 in.x10 Mesh	1.60
22	1½ (or 1) in.x10 Mesh.	1.50
23	2 in. Screenings	1.50
24	1½ (or 1 or ¾) in. Screenings	1.40
25	⅜ to ¼ in. Screenings	1.10
	DRY DEDUSTED	
26	2 in.x8 Mesh	1.35
27	1½x8 Mesh	1.25
28	Carbon to 10 Mesh	0.85
29	Carbon to 28 Mesh	0.85
	WATER DEDUSTED	
30	2x10 Mesh	1.40
31	1½ (to ¾) in.x10 Mesh	1.30
32	Carbon	0.90

Table II. Accepted names and average sizes of coals as commonly used in the Illinois and Indiana areas. The two figures represent maximum and minimum size lumps, thus 3 by 2 in. or No. 1 nut means all the lumps pass through a screen with 3 in. holes and lumps will be retained on a screen with 2 in. holes. Mesh designates the number of wires per inch in the woven wire screens used for the small sizes

SIZE in in. or Mesh.	ACCEPTED NAMES
Plus 6 in.	Lump
Plus 3 in.	3 in. Lump
Plus 2 in.	2 in. Lump
Plus 1½ in.	1½ in. Lump
6x3 in.	Egg or Furnace
6x2 in.	6x2 in. Egg
6x1½ in.	6x1½ in. Egg
3x2 in.	No. 1 Nut
3x1½ in.	3x1½ in. Nut
2x1½ in.	No. 2 Nut
1½x¾ in.	No. 3 Nut
¾x⅜ (or ⅜) in.	No. 4 Nut
⅜ (or ⅜)x0 in.	No. 5 Carbon
2x 0 in.	2 in. Screenings
1½ (or 1¼)x0 in.	1½ (or 1¼ in. Scr'n'gs
¾x0 in.	¾ in. Screenings
2x⅜ in.	2 in. Special Stoker
1½x⅜ in.	1½ in. Special Stoker
1¼x⅜ in.	1¼ in. Special Stoker
2x?	2 in. Dedusted Screen'gs
1½x?	1½ in. Dedust. Scr'n'gs
¾x?	¾ in. Dedusted Scr'n'gs
⅜ in.x10 Mesh	10 Mesh Carbon
⅜ in.x48 Mesh	48 Mesh Carbon

sometimes coloring, factors which will be touched on briefly later.

A price structure based on size and size alone is an inheritance from the past when the finer coal was more likely to have higher percentages of dirt. Today that condition does not exist for the modern washer will clean fine coals as well as coarse coal. In fact in the laboratory, using the float and sink process, the finer the coal the more perfect the separation.

Basically a lump of coal is the same when broken in two as it was originally. Obviously the only thing changed is the size of the lump, so it should have the same heating value as before. Why, then, should a large lump carry a higher price than when broken into several pieces?

The answer, showing the cost as influenced by modern preparation methods beyond sizing, is given in Table I. The only true measure of coal value to the ultimate consumer, in the writer's opinion, is what may be called a USE VALUE, made up of a Form Value, Quality Value and Suitability Value. From a background of experience, evaluation of these factors can be made within wide limits although close determinations can be made for a specific application only by test.

Sizing

Some 32 size groups, with official mine prices for shipment to the Chicago area, are given in Table I. The first 16 groups for raw coal only show the influence of size on price, which runs from $0.30 to $1.95 per t. a difference of over 300 per cent. The influence of washing and dedusting on price is shown by a comparison of the later size classes.

Many of the sizes are known by common names. Limits of these classes vary somewhat from field to field but Table II shows the common or accepted names used in Illinois and Indiana. While Tables I and II (the first for a specific area, the second more general) differ in detail, the various size groups dovetail together fairly well.

The great number of sizes show the extremes to which producers have gone in the past in an endeavor to satisfy critical customers. Since the development of washing and dedusting operators have gone the limit in breaking down the finer sizes as shown by Table III. In contrast to the situation with bituminous coal, note the simplicity of the size system approved by the Anthracite Institute for anthracite and shown by Table IV. Table V shows the size system used by the coke producers, who, although dealing with smaller physical sizes, have also recognized the value of simplicity.

Changes During Shipment

When it is realized that bituminous coal is relatively soft, as compared to coke or anthracite, and will markedly change size by both weathering and breakage in handling, the multitudinous fractional sizes verge on the absurd. A coal may be accurately screened at the mine, but due to loading, unloading, handling and stoking, may go into the furnace something entirely different. Again, the difference between 1½ by 5/16 in. and 1¼ by 5/16 in. or ¾ by 5/16 in. and ¾ by ⅜ in. is so slight that it is practically impossible to tell them apart. As a matter of simple combustion engineering the use value would simply be indistinguishable.

Why, then, complicate and confuse the whole business by any such absurdity? Why not adopt a simple, straightforward size system as shown by Table VI? Here are seven standard sizes with two sub-sizes of No. 7. Each size has upper and lower limits sufficiently close that the pieces appear, from a little distance, to be all of one size. A load dumped on the ground shows no segregation, neither is there any appreciable segregation in the bunker or stoker hopper. At the same time, the sizes are sufficiently numerous and the differences so nicely graded that a change from one to another does not involve a radical change in handling or firing.

There is nothing in this size system that interferes with washing, dedusting or any other quality effect. It does admit of special sizings by grouping several of the standard sizes and even of varying the percentages of the intermediate sizes. The numbering system is merely a convenience in referring to a given size.

While each size is given a number, it is possible to use the system to indicate any upper and lower limit for a composite size. For example, what is generally known as 2 in. lump would be indicated by Number 13, that is, everything down to and including 2 in. coal.

Washers are usually set to operate at from 1.45 to 1.55 gravity. Obviously, there will be many pieces of part coal and part rock that will just be over the critical point that will go off with the heavy impurities and be lost. The loss thus in-

Table III. Since washing and dedusting have been introduced, the finer sizes have been broken down into several groups. The sizes below cover both washed and unwashed coal

SCREENINGS	DUST SIZES
3/8 in. x 10 Mesh	
1/4 in. x 10 Mesh	
3/8 in. x 4 Mesh	10 Mesh x 0
1/4 in. x 4 Mesh	
3/8 in. x 28 Mesh	28 Mesh x 0
1/4 in. x 28 Mesh	
3/8 in. x 48 Mesh	48 Mesh x 0
1/4 in. x 48 Mesh	

curred may run as high as 20 per cent.

Inasmuch as the raw coal coming from the mine may, and usually does, carry varying quantities of impurities, the washing process is definitely a great step toward a uniform and constant quality of product. So many coals admit of improvement by washing that the process is now used everywhere and the washing of coals accepted as a standard element in coal preparation.

Coal Is Separated Into Various Sizes

When the coal first comes from the mine it is separated into various sizes. The coarse part, or lump, is fed on to a moving belt or "table" in a thin layer so that each piece can be seen. Men stand on each side and pick out the larger pieces of rock, slate or clay and throw them into a chute for later disposal. In this way all the visible impurities are taken out and the clean lump goes to the railroad car.

As a means of distinguishing their coal from all others, certain producers have copyrighted a trade-mark consisting of a color sprayed on the coal as shipped. "Blue Coal" or "Green Marked Coal" are two names that occur to the writer. This identifying mark is, of course, confined to the particular producers controlling the copyrights.

Oiling and Water Dedusting

To allay this dust, important in household use and in some industrial applications, a method of coating the particles of coal with oil has been worked out and used quite successfully of recent years. As the coal goes to the railroad car it passes through a fine spray of oil which coats the pieces and sticks the finer particles of dust on to the lumps.

Various kinds and grades of oil have been used. The difficulties encountered are: the absorption of the oil by the coal, thus losing the surface coating; and, the evaporation of the oil if long exposed to the weather. There have been cases, also, of excessive application causing an oily smear to develop on shovels, conveyor belts, stoker hoppers and the basements floors.

In general, however, it may be said that correct oiling does allay dust that would otherwise be very objectionable, and many consumers demand "dust-proof" coal. Most producers and many retailers are equipped to prepare coal in this way. Recently, however, wartime restrictions have curtailed the use of oil for this purpose. Calcium chloride, (a deliquescent agent—one which absorbs water) has been tried in a limited way.

This has brought about a rather acute situation, in that users demand a dustless coal and stoker manufacturers and many users keenly object to the destruction of stoker parts by the corrosive action

Table V. Coke sizes and names as commonly used

NAME	SIZE
Egg	3x2 in.
Range (or stove)	2x1 5/8 in.
Nut	1 5/8 x1 in.
Pea	1x1/2 in.
Breeze	Minus 1/2 in.

of calcium chloride. For the duration the continued treatment of coal to allay the dust apparently rests upon the discovery of an acceptable substitute material to replace the oil.

A simple and nearly universal means for reducing the dust on domestic coal is by subjecting it to a strong spray of water while passing over a vibrating screen. Dust particles clinging to the larger pieces are thus simply washed off and pass through the screen with the waste water. A definitely cleaner product is thus secured.

Mine run would be No. 17. Stoker nut would be 56. For domestic use, No. 2, 3 or 4, or perhaps No. 24, assuming in this numbering system, that if an upper limit of 6 in. and a lower limit of 1¼ in. is desired, then everything in between is wanted. If, perchance, a special size is really needed, a specification calling for, say, No. 3, 40 per cent and No. 6, 60 per cent, makes it practical to get any combination desired for special use.

At this time there appears to be no contemplated restrictions in the number of coal sizes, but all producers are confronted by the problem of no bills on odd sizes cutting

Table VI. Simplified bituminous coal size system recommended by the author as meeting all practical needs of the coal operator and user

NAME	SIZE
No. 1	Plus 6 in.
No. 2	6x3 in.
No. 3	3x2 in.
No. 4	2x1¼ in.
No. 5	1¼x¾ in.
No. 6	¾x¼ in.
No. 7	¼x0 in.
No. 8	¼x⅛ in.
No. 9	⅛x0 in.

down their car supply the following day. There is also the constant worry of having to satisfy customers and possibly of having to run off a few cars of some special size not ordinarily made. Fewer sizes would help from every angle.

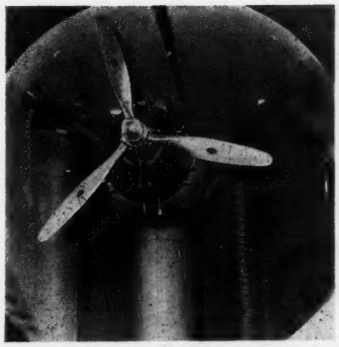
Washing

So called washing of coal is in reality a process of eliminating or reducing the impurities by gravity separation while suspended in a fluid medium. The effectiveness depends upon the difference in specific gravity of the coal and its mechanically mixed impurities. The differences between the two causes the heavier particles to sink while the purer coal either floats or sinks more slowly. Various systems are in use. Each does a good job when adjusted to the particular gravities of the coal being treated.

Inasmuch as many little pieces of coal are attached to a piece of clay, shale or other heavy impurity, with a weight somewhere between the weights of either pure coal or solid impurity, there must be a certain wastage of coal if all the rock is to be taken out. Pure coal has a specific gravity of 1.20 to 1.35, while the foreign matter usually runs from 2.5 to 5.0. With such a difference it is obvious that the heavy material will sink very rapidly.

Table IV. Simple sizing system used for anthracite, with the accepted names of each

NAME	SIZE IN INCHES THROUGH, IN.	OVER, IN.	COMMENT
Broken	4 3/8	3 1/4	.....
Egg	3 1/4	2 7/8	Largest domestic size
Stove	2 7/8	1 5/8	For larger fire pots
Chestnut	1 5/8	13/16	Small heaters and kitchen ranges
Pea	13/16	7/16	Same service if draft is good
Buckwheat	7/16	7/32	Smallest natural draft size
Rice	7/32	5/32	Often called No. 2 Buckwheat. Requires fan.
Barley	5/32	3/32	Often called No. 3 Buckwheat, for forced blast stokers only.



Bomber engine mounted on propeller test stand where engines are given engineering and other test runs which are not part of the production procedure

BUICK FACTORY
Assembles Army Aircraft Engines

Utility supplies power with arrangements for absorbing surplus power generated by engines on test. Factory, with acres of floor space completely built, equipped and put into production between March and December, is model of convenience, comfort and production efficiency

By Ralph E. Turner,
Editor

IN JUST 8½ mo. from the time excavation started on the construction of the Buick factory for assembling and testing aircraft engines, the first units were ready for delivery. That was in December, and now, 7 mo. later, the plant is producing engines at a rate a year in advance of the preliminary estimated production for this date. While these accomplishments would be considered rapid even for a small factory, they are almost phenomenal when the size and degree of perfection of this undertaking is considered.

On March 17, 1941, steam excavating shovels first started their work and electricians began laying cables to supply light to carry on night work. To complete the factory 410,000 bags of cement were required, excavation totaled 5,500,000 cu. ft., a railroad was built, 2500 tons of reinforcing steel and 10,000 tons of structural steel were used, 1,158,000 sq. ft. of cement roof tile and 12,000 sq. ft. of composition roofing went into the structure, also 150,000 panes of glass and 186,000 sq. ft. of steel sash.

For servicing the factory with mechanical, electrical and other conveniences, the buildings and grounds contain 15 mi. of heating pipes, 575 motor driven fans for ventilation, 75 mi. of electric conduit, 250 mi. of electric wire and cable, 300,000 lb. of copper for power wiring, 9500 fluorescent light fixtures. A cafeteria that will accommodate 2000 at one sitting and additional lunch rooms to handle 1200 more are figures that indicate the number of workers which are expected to be employed.

In every way this large new factory is modern and designed for efficiency, but a study of its construction and equipment impresses one with the evident fact that the designers had no time nor inclination to experiment with untried practices or equipment. Speed was the all important word during the construction of this factory, not forgetting in the equipping of the

Fig. 1. One of the first Buick-built Pratt & Whitney aircraft engines which had just completed its acceptance test run received the personal inspection of Harlow H. Curtice, Buick president and general manager, and Major E. H. Bowman, resident Air Corps representative

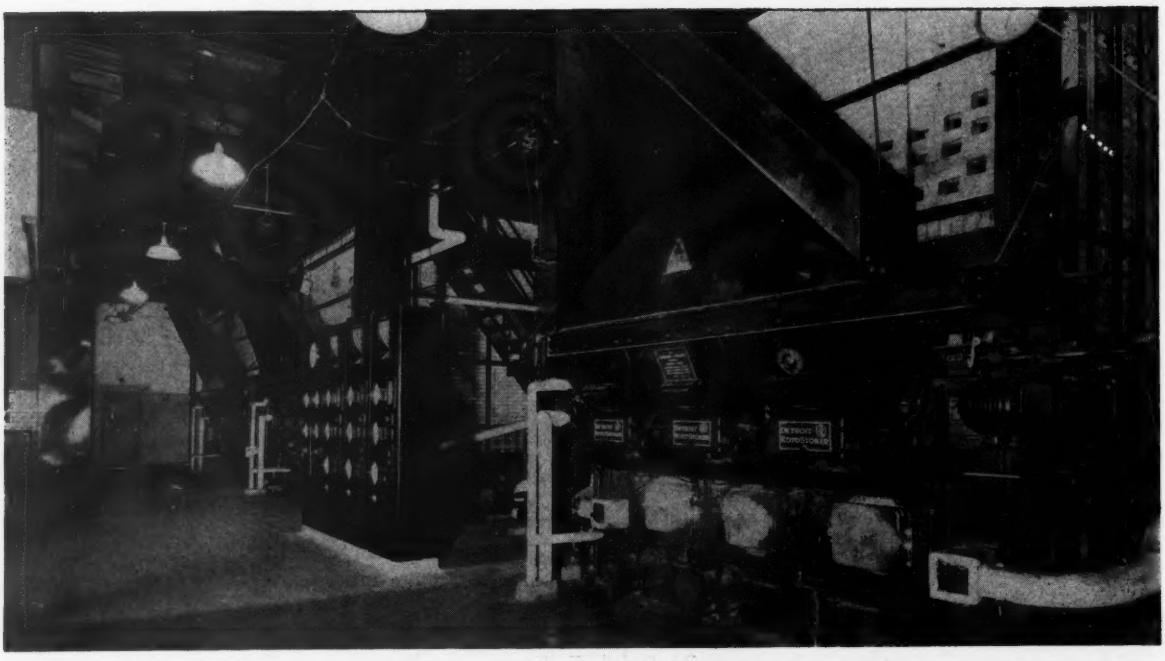


Fig. 2. Buick's boiler plant, equipped with strictly modern automatic controls and instruments, contains three water tube boilers with a fourth being installed

plant that speed in construction must be followed by speed in the production of engine units.

The plant is, therefore, streamlined to produce its product as swiftly as modern tools manned by skilled workmen can make it, and yet maintain a thoroughly reliable and efficient product which is proved by rigid factory tests. And back of the tools are the workmen whose comfort and health are provided for and maintained with extreme care.

Building Features

Connected by common walls are the administration building, the main manufacturing building, a garage and the dynamometer building. Other buildings in the group include a personnel building, a boiler house and several minor structures.

The architectural design of all the main buildings provides excellent day lighting. The factory building, for example, is one-story high with monitors extending the entire length of the building. Continuous steel sash windows on three sides of the building, including the monitors, are of a special type, heat-resisting wire glass that affords even daylight distribution throughout the plant without glare.

All artificial lighting, except in corridors and non-working spaces, is supplied by fluorescent units suspended from the ceiling while an overhead bus duct system provides electrical outlets every 12 in.

Artificial Lighting

The network wiring of the lighting system is in conduits of the conventional type with outlets for the units conveniently spaced throughout the entire building. The fluorescent lamp units used each have two tubes and simulate daylight in their color effects. For offices the units employed are of 40-w. capacity while those in the factory are 100 w. The lighting intensity at working levels varies from 25 to 30 foot-candles and, since this type of lighting gives soft shadows, it has been

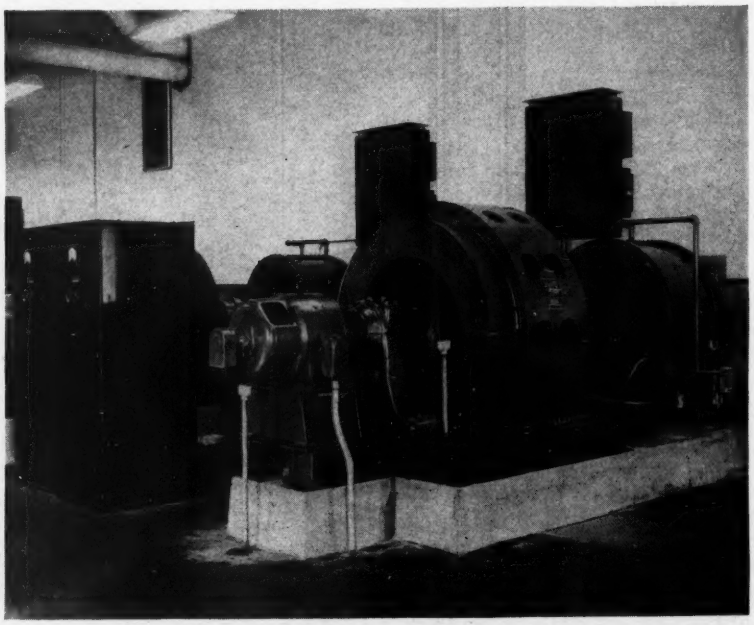


Fig. 3. Elements of testing unit located outside testing cell. Seen here are the exciter, the alternator and the magnetic coupling. The engine under test is at the far end of the shaft which extends through the wall

found to be extremely satisfactory in applications of this sort. The manufacturing building alone is supplied with 9500 of these fixtures.

The lighting circuit is fed by transformers at 208-120 v. on a 4-wire system which is a complete ring with network protectors that, in case of failure of any one transformer, act automatically to isolate the defective transformer and throw the load it has been carrying upon other transformers in the network.

Power for the operation of factory machines and tools is supplied at 440 v., 3-phase, to bus ducts conveniently located throughout the entire factory. To these buses individual machines are connected at any point selected. The power buses differ somewhat in their operation from the lighting circuit in that, under normal conditions, the individual buses operate separately. Nevertheless there is a secondary bus tie connection possible whereby in case of failure of a power transformer the secondaries can be connected to an adjoining substation and the essential power line kept in operation.

Heating and Ventilating

In winter the factory building is heated by overhead unit heaters of the projection type. The space is divided into four zones and thermostats regulate the artificial heat in accordance with the amount of sunshine in each zone. Steam supplied for this purpose is the exhaust from air compressors in the boiler house supplemented by live steam through reducing valves when conditions require more heat than is available in the exhaust steam.

Ventilation is designed to be ample in case of blackouts and to keep the inside temperature within 10 deg. of that outside. In this system are 575 motor driven fans including 210 intake and 210 exhaust ventilators equipped with 10,000 c.f.m. fans or approximately 2 c.f.m. for every square foot of floor space.

Complete air conditioning is provided in the administration building, also in the manufacturing building offices located on the mezzanine of the main manufacturing building and the employes cafeteria, located in the basement. Other space leading off the basement corridors is occupied by additional lunch rooms, service rooms, fan rooms, refrigeration equipment and utilities.

Fig. 4. Production men working on aircraft engine cylinder heads in Buick plant use a variety of electrically driven tools where the light intensity ranges from 25 to 30 foot-candles

Fig. 5. Performing a finishing operation on an assembled crankcase of a Pratt & Whitney aircraft engine in the Buick plant

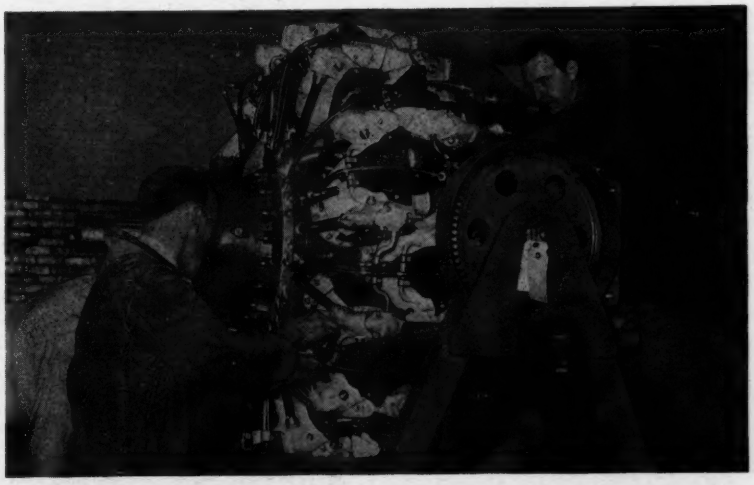


Fig. 6. Bomber engine being prepared for its initial run in the test stands. Each engine is given a complete test for efficiency and operating condition in order to insure that, when installed in an airplane, it has already been conditioned for full capacity operation. Power generated during these tests is fed back into the electric system

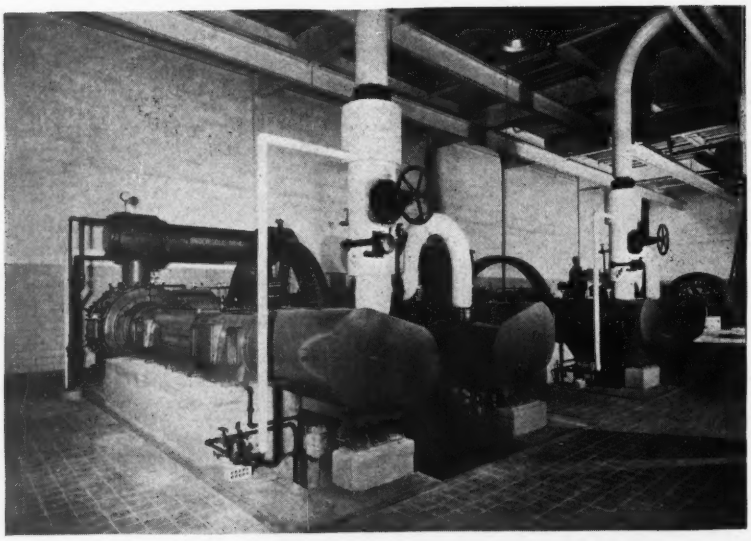


Fig. 7. Compressed air is supplied by two steam driven and one motor driven compressors located on the operating floor level of the boiler plant

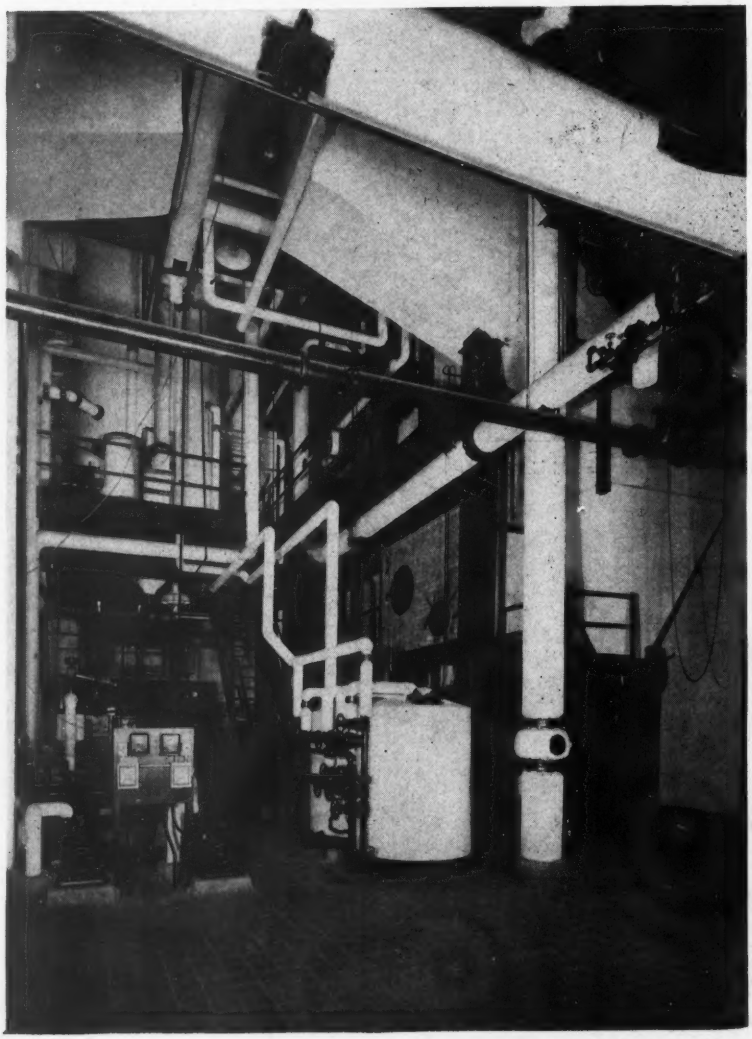


Fig. 8. Feedwater treating and heating equipment is centrally located between boilers Number 2 and 3

One of the outstanding features of this factory is the modern hospital which is housed in the personnel building together with personnel and employment departments. In addition there are several first aid stations throughout the factory all fully equipped to care for emergency cases or minor injuries.

Electricity for light and power is both purchased and generated. The purchased electricity is transformed through a system of well distributed transformer substations from 35,000 to 440 v. for power and 208-120 v. for lighting. All transformers are oil immersed, self-cooled. The distribution panels are conveniently arranged in two facing rows and a storage of adequate capacity is provided for switching purposes and emergency lighting.

Power From Engines on Test

An innovation in the arrangements for purchasing power is the provision for pumping surplus power generated by the engines under test back into the utility company's lines. As previously stated, this factory was built for the purpose of assembling and testing aircraft engines. These are of the Pratt & Whitney design.

Testing the engines is an operation of major importance in the work of the factory and carefully studied plans have been worked out to speed up the operations of hooking-up and disconnecting the engines. It is reported that with formerly used methods the time required to set up an aviation engine for testing required from 3 to 6 hr. because of the main electrical, oil and pressure connections that must be made in the testing cells. In this plant with the method devised an expert crew can make the connections in 25 min. or less.

While under test, the noise level in the vicinity of one of these engines is 135 decibels, an intensity close to the limit of human endurance. For testing purposes, therefore, cells were built with sound-insulated concrete walls and an observation window behind which the test engineers carry out their work in space where the sound volume is only 57 decibels which is comparable to the noise in a turbine room.

In this plant some of the test cells are provided with equipment for feeding power back into the supply line. With the engine in a test cell, it is so connected as to form one element of a three-ele-

Fig. 9. Each of the three enclosed automatic coal scales is provided with three chutes from bunker openings used separately to assist in maintaining even distribution of coal in bunker

ment unit, the other elements being a magnetic coupling and a synchronous alternator, all mounted in line, the shaft being provided with necessary couplings and passing through the sound insulated wall between the engine and the magnetic coupling.

Engines on Test

To put an assembled engine on test, it is erected in a test cell with its shaft connected to the power generating equipment which is kept permanently in place; all piping and instrument connections are made and the cell door closed. The synchronous alternator, which has a capacity of 1000 kv-a., is then started as a motor; next the magnetic coupling is energized to turn over the engine on test which is then fired and brought up to speed. The magnetic coupling absorbs the slip energy between the engine speed and the synchronous speed of the alternator. At all engine speeds above 900 r.p.m., the synchronous speed of the synchronous alternator, the alternator is feeding energy back into the lines as a generator. It is estimated that an engine on test will turn back an average of more than one-third its capacity in the form of electric energy.

The test building runs at right angles to the assembly lines in the manufacturing building, the engines being transported from the assembly department by means of three bridge cranes with underslung, detachable cabs that can leave the crane and operate independently on a monorail. These convey the finished engines into the test cells and return them to the tear-down and re-assembly department.

In addition to production test cells, two engineering test cells are provided, one in which the engine is run against a propeller and the other in which a single cylinder instead of the multiple engine is tested.

Water used for heat exchangers, magnetic couplings, etc., is passed through a three-unit cooling tower rated at 5000 g.p.m. when reducing the temperature from 95 to 85 deg. F. with atmospheric air at 78 deg. wet bulb temperature.

Facilities from Steam Generation

Stirling type water tube boilers are installed with all the necessary auxiliary equipment and a complete complement of instruments and controls.

The boilers are designed for 200 psi. but are normally operated at 175 psi, 420 deg. F. The furnace

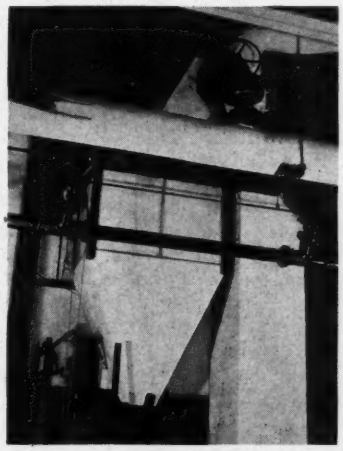


Fig. 10. Cinder catchers and cinder burner equipment

has three water walls and fuel used is Illinois coal, fired by spreader type stokers, three units per boiler, employing both forced and induced draft under automatic combustion control, that part of the combustion air introduced through the fuel bed being preheated to 325 deg. F., the over-fire air used to produce turbulence, however, is not preheated. Excellent combustion is obtained and with the employment of fly ash eliminators no difficulty has been experienced with dust settling in the neighborhood nor the nuisance of smoke.

Coal and Ash Handling

All coal comes to the plant by rail cars and is either delivered directly to the receiving hoppers of the coal conveying system or placed in the storage pile where an adequate supply is kept on hand. Storing and reclaiming is done by means of a clamshell bucket operated from a crane mounted on a caterpillar type truck.

The coal conveying system consists of a bucket elevator which delivers the coal from the track hoppers to a distributing belt over the boiler bunkers. Beneath the bunkers are automatic coal scales which discharge through chutes to the stoker hoppers where the coal is kept from segregating by means of a conical type spreader. The ash conveying system is of the steam jet type and delivers to a silo with sufficient capacity to hold the accumulation of 1 wk. operation. The silo discharges directly to the railroad cars.

Water Supply

Raw water used for boiler feed make-up normally comes from the hot returns to the cooling tower and has a hardness of 28 gr. per gal., but by means of a hot process lime-soda and phosphate treatment the hardness is brought down to 1½ gr. per gal. in which condition it is delivered, along with the returns from the heating system, to a 3000 g.p.h. deaerating feedwater heater. Three feed-pumps are provided for handling this water, one being a motor driven centrifugal, one a turbine driven centrifugal and one a steam driven reciprocating pump.

Steam generated by these boilers, except for that used by the auxiliaries, is used to drive air compressors, the exhaust from which goes to the heating system of the factory at 35 psi., this being reduced to necessary requirements at different points in the system.

These steam driven air compressors and another motor driven unit supply air for manufacturing purposes at 90 to 100 psi. pressure.

Yes, in every detail this entire manufacturing plant is modern, being built and equipped almost completely with materials, machinery and parts that were quickly obtainable on the market and considered standard by their manufacturers. This policy on the part of the architects and designers, Albert Kahn of Detroit, undoubtedly laid the foundation for the exceptionally rapid completion of the entire project by the general contracting firm, Thorgersen and Ericksen of Chicago.

ELECTRICAL MAINTENANCE OF

There has always been considerable misunderstanding in regard to the insulation resistance of electrical machinery. As a rule the insulation resistance of an electrical winding varies under varying conditions of temperature, humidity, atmospheric pressure, etc., and the value of an insulation resistance measurement has significance only when it is compared to another measurement taken at a different time. In this article Mr. Askey gives some practical and valuable suggestions on this vital subject

By JOHN S. ASKEY
Coil and Insulation Engineer
Westinghouse Electric & Manufacturing Co.

THE WINDINGS of large rotating machines appear, to the casual observer, to be so simple and rugged, that little thought is given to a maintenance program for this part of the machine. This idea must be corrected for here are great masses of laminated materials, bonded together in several ways. These bonds are naturally affected by aging, vibration or other mechanical disturbances. The windings

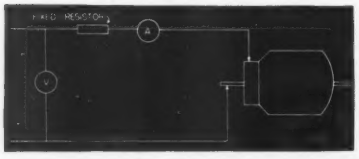


Fig. 1. Connections for using the microammeter method of testing

are, except in cases of hydrogen-cooled units, subject to various degrees of dirt, oil and moisture.

The first inspection of the windings should be made not later than 1 yr. after date that operation began. This inspection should indicate any change in the position of windings upon their mechanical supports. This will undoubtedly give an indication of their adequacy, assuming operation up to this time has been normal. It will also provide the operator with information regarding conditions of the windings and other parts before expiration of the customary warrantee period. At this time the operator should take the insulation resistance of the windings for the second time —the second time, because such a reading should have been taken before the unit was started up; however, if this was not done, it is definitely not too late. This is because the manufacturer in most cases can furnish the insulation resistance value of this particular unit before it left the factory. At this time also may be observed the type of winding surface protection provided by the insulation actually in service as compared to that anticipated in specifications. This is important for any adverse operating conditions may have already begun their attack upon the machine and corrective steps may be taken before damage is severe. In other words, an inspection at this time will indicate how well the equipment is adapted to its purpose and if it has been properly operated.

The subject of insulation resistance has been a problem for concentrated investigation for the past several years by various groups, and while the variance of insulation resistance has not been correlated with dielectric breakdown, its use is very desirable in determination of the condition of machine insulation. So, if no record was made of such a value at the time the machine entered the customer's system, and if the manufacturer cannot provide a "benchmark" or original reading, begin at once because the correct diagnosis of the condition of the windings cannot be arrived at by a single reading. To be of value, readings of insulation resistance must be used with a considerable degree of intelligence as insulation resistance itself is extremely variable and the type of insulation must be taken into consideration. As the insulation resistance is taken by applying a suitable voltage from the conductor to the iron core, the main slot insulation almost entirely determines the value obtained, but this value is affected by the condition of the end windings, or portions extending beyond the iron core. This means that thoroughly reliable

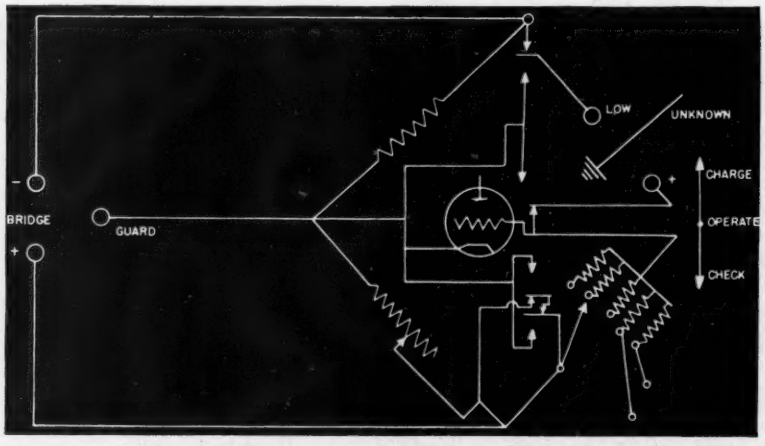


Fig. 2. Schematic wiring diagram of the electronic bridge

LARGE ROTATING MACHINERY

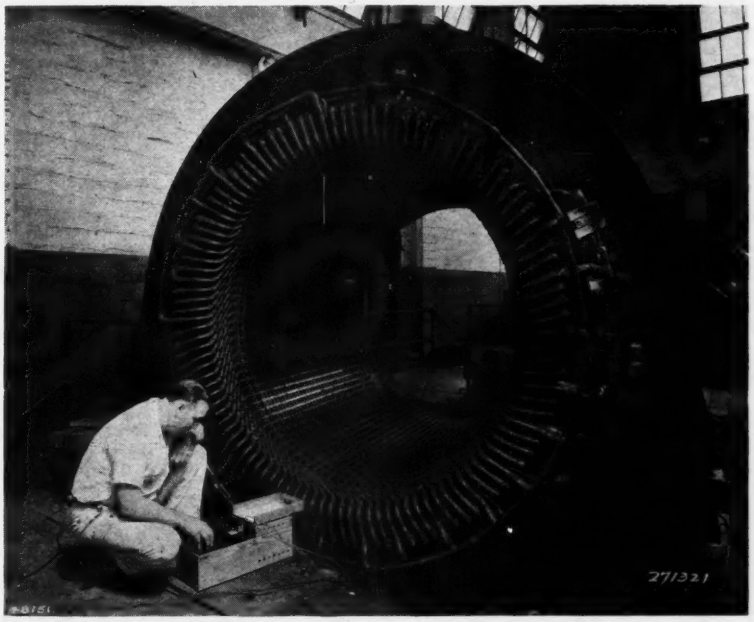


Fig. 3. Using the electronic bridge in testing the insulation resistance of the winding of a large rotating machine

slot insulation coupled with dirty end windings will not result in satisfactory insulation values until after thorough cleaning of the end windings. To accurately forecast insulation conditions, it must be remembered that each part of a system must be considered separately. That is, values cannot be accepted if taken upon a motor's stator winding with great lengths of cables, oil switches, contacts, etc., still connected to the winding. Therefore, the first problem in insulation resistance is to isolate the part being studied.

When ready to measure insulation resistance, what equipment and method shall be used? The three methods used today are the Megger, micro-ammeter and electronic bridge. Each has its advantages and disadvantages.

The Megger, considered the simplest, is self-contained, requiring no external voltage supply, but voltage can only be supplied to the winding during the time the operator can steadily and continuously crank the device. Therefore, its use is limited to an observation of insulation resistance during the first few seconds when the value is rapidly changing, due to the winding being charged, and any reading taken cannot be considered the true insulation resistance. This rate of change indicates the rate of volume charge of the insulation or its dielectric absorption. A motor-driven Megger will overcome the short time limitation.

The Megger provides a simple method, satisfactory for short time tests of electrical machines and circuits. It should be used with intelligence, however, and the reckless use of "infinity" obtained from any low range instrument should be avoided.

The micro-ammeter and electronic bridge require a separate source of voltage supply. Of the two, the micro-ammeter method requires the highest voltage, utilizing 500 v., d.c. from a constant potential source, preferably ungrounded. The micro-ammeter method permits very accurate readings if a constant potential d.c. source of 500 v. and a micro-ammeter with scales of 0-10 and 0-100 are available. As shown in the diagram of connections of this method in Fig. 1, a series resistor should be used if necessary to limit the current at the voltage used to the capacity of the meter, and a voltmeter across the supply.

The electronic bridge can be obtained for operation at 110 v. and 25 to 60 cycles if desired, as it employs a built-in rectifier which is properly regulated and filtered. The output voltage of this bridge is 500 v. d.c. The electronic bridge, as commercially available, utilizes the direct-current Wheatstone bridge which has adequate sensitivity for indicating the bridge balance through the use of a vacuum-tube voltmeter. In spite of its name, the bridge is easy to read and operate, and weighs less than 30 lb. including built-in power supply. It applies 500 v. to the part on test and its other advantages are low cost and it can be "plugged-in" to any 110 v., a.c. 25 to 60 cycle outlet. The instrument has a range of from 100,000 ohms to 1,000,000 megohms and its controls are direct-reading in megohms, no calculations being required. Another feature of the bridge is the "guard" terminal. This is very useful to eliminate any error due to surface leakage. The schematic diagram of the bridge is shown in Fig. 2. In ordinary testing, it is not always practicable or desirable to use the guard circuit for the effects of surface leakage may be those contributing to the fault.

The operating voltage of the

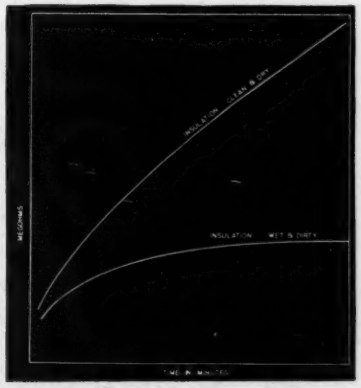


Fig. 4. Effect of moisture or dirt upon the insulation resistance

equipment to be tested must be considered as rotor voltages are usually much lower than stator voltages, except in the case of the wound rotor induction motor. For this reason, the application of higher than 500 v. to the winding should be avoided.

As stated earlier, insulation resistance changes rapidly after the application of voltage. In spite of this fact, it has become a practice to use the apparent value as taken at the end of 1 min. application of voltage. This practice is reasonably satisfactory for study of most insulations. It is not, however, sufficient for windings of high voltage equipment, as these windings often require many hours to reach equilibrium. The slope of the curve obtained by plotting insulation resistance against time over a 15 min. period will throw an interesting light upon insulation condition as illustrated in Fig. 4, for the time required to charge up a wet or dirty winding is much less than required for the same winding that is clean and dry. An exception to this are machines operating at high voltage whose stator end windings are treated with Coronox for corona elimination. The effect of the semi-conducting treatment used can be seen in the change in slope of curve as shown on Fig. 5. Figure 3 illustrates the use of the electronic bridge. High values of insulation resistance must not be construed as representing high dielectric strength, for an insulation may be damaged mechanically and have a very high resistance, yet it will fail at a relatively low potential test voltage. For this reason, when a machine that is enclosed has suffered an accident it is not enough to merely "Megger" the stator and rotor. Instead the machine should be examined for mechanical damage before returning to service.

After an initial reading of an equipment has been taken, the process should be repeated using the same instrument, and results recorded. The frequency of these readings depends upon the application and may vary from 1 wk. to 6 mo. There are no hard and fast rules which can be laid down for insulation resistance, but it is known that several readings plotted at about the same value followed by one or more points of much lower value, give an indication of moisture, dirt or insulation deterioration. This is only true if the values are co-ordinated with temperature, as insulation resistance fluctuates with temperature and humidity. It is for this reason that winding temperature must be recorded every time insulation resistance is taken. The effect of temperature can generally be calculated by the following formula:

$$R = rC^n$$

where

R = Insulation resistance at higher temperature (T deg. C.)

r = Insulation resistance at lower temperature (t deg. C.)

C = Constant
For Class A (A.I.E.E.) insulation = 0.44
For Class B (A.I.E.E.) insulation = 0.63, except for high voltage units which do not have the same temperature coefficient.

n = Exponent $(T^\circ - t^\circ) + 10$

T = Higher temperature, deg. C.

t = Lower temperature, deg. C.

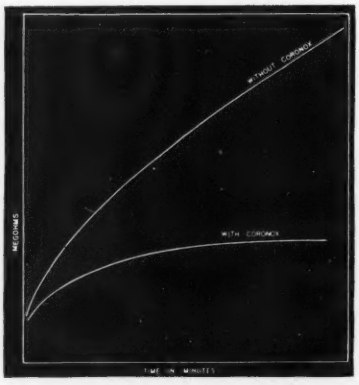


Fig. 5. Effect of "Coronox" treatment on the insulation resistance-time relationship in a completely wound machine

With temperature corrected for, there will be cases where the values or points of the record chart fall so low that something must be done to raise the resistance in order to make the machine safe for operation. There are some machines, however, which have a low resistance which does not change. Such a machine is probably safe to operate, but an effort should be exerted to find the cause of the low values and correct same.

In considering low values, the insulation resistance of clean, dry windings, to meet the A.I.E.E. rules, should be in megohms equal to:

$$R_i = \frac{E_r}{(\text{Kv-a} \div 100) + 1000}$$

where

R_i = Insulation resistance

E_r = Rated voltage of the machine

Kv-a = Rated kv-a. for a.c. machines or kw. for d.c. machines.

In conjunction with this elaborate rule, many maintenance engineers follow the practical value of "one megohm per 1000 v.", which fits closely into the formula especially for ratings up to 5000 kw.

Many prefer periodic application of high voltage tests to windings in spite of possible breakdown. This sort of testing must be controlled carefully and intelligently. All windings, when new and before leaving the factory, have successfully withstood high-potential tests as prescribed by the A.I.E.E., namely:

For stators = Twice normal voltage + 1000 v.

For rotors = Ten times exciter voltage, except induction motor wound rotors, which are tested the same as stators.

It has long been realized that dielectric tests impose a stress upon the winding and if repeated frequently enough may be directly the cause of failure. For this reason, the use of such tests in the field have varied widely. Any repaired winding is no stronger than the weakest coil that was not replaced, so any testing increases the possibility of further damaging the winding. Therefore, the test of any repaired winding should be limited to 70 per cent of the original factory test. Periodic tests of equipment should not be made at voltages over 60 per cent of factory tests. Complete rewinds should be tested the same as new equipment.

Much has been printed regarding the cleaning and treatment of windings in varnish to raise insulation resistance. In passing, it is important to consider the application of the machine before indiscriminate treatment is applied. Where one winding requires a hard, glossy finish to protect against moisture or oil, another must have a tough resilient "hide" to withstand bombardment of foreign material in the air stream. Therefore, consult your manufacturer for the correct materials and proper application of them.

The Part of Correct Lubrication in Equipment Maintenance

BY SAM S. HANSEN
Chief Lubricating Engineer
General Petroleum Corp. of California

Part I. Plant workers can do much toward helpful co-operation with the Maintenance Department to keep equipment in good condition and production at a maximum. Thousands of new maintenance men, oilers, machinists, and engineering apprentices are filling new jobs and it is hoped that some of the practical suggestions given here will help to make their work easier and more effective, and that our National War Program may move forward with ever increasing strides. Part I of this two-part serial deals principally with the lubrication problems of steam turbines. Part II, to be published in a subsequent issue, will take up the lubrication of air compressors and electric motors

"PREVENTIVE MAINTENANCE" under conditions of stress for maximum production is an important activity of the mechanical department in national war industries. Excellent care taken of mechanical equipment results in the following principal benefits:

1. Uninterrupted production of essential war materials.
2. Increased speed of output.
3. Freedom from breakdowns and repairs. Repair labor costs reduced.
4. Economical operating costs, because of elimination of purchase of expensive replacement parts, which may also be difficult to obtain.
5. Power consumption reduced.

The efficiency of the mechanical maintenance department can be judged by the size of the scrap pile in back of the repair shop. Is it filled with worn-out armatures and shafts, scored cylinders and pistons, broken valves and gears, burned out bearings, broken balls and races, and parts which have become inoperative because of rusting or corrosion, or deposits left behind by poor lubricants? Is the shop bristling with activity in repairing worn-out parts? Is the mechanical department judged by its ability to repair broken down machinery, or by its ability to prevent wear and breakdowns? The latter may appear less spectacular, but it is certainly the way to gage the ability of the maintenance department.

Correct lubrication plays a somewhat obscure, but exceedingly important part in any plant which is straining for maximum production. As an example of this point, suppose that the oil film in the turbines of the main power plant should fail. If failure of this film occurred for as little as 1 min. the turbine bearings would be destroyed and the whole plant would be down. The same analysis, of course, also applies to any main item of plant machinery.

The important part played by good lubricants has been realized by the majority of capable mechanical men the country over since the inception of the defense program. This point has been proven by the fact that the use of first quality lubricants has exceeded the general gains in industrial activity. Secondary quality oils and greases are being replaced by first quality lubricants.

Obtaining Trouble-Free Operation

The whole purpose of this article, however, is the writer's desire to emphasize the point that a sound maintenance program depends upon several major steps which are all interrelated and the final result of trouble-free operation, cannot be attained without due consideration of each. These main steps are:

1. Setting equipment in good mechanical condition before expecting maximum output of power or production.
2. Establishing a systematized routine for regular periodic care of machines and equipment.
3. Selection of correct lubricants and using them in the right way and right amount.

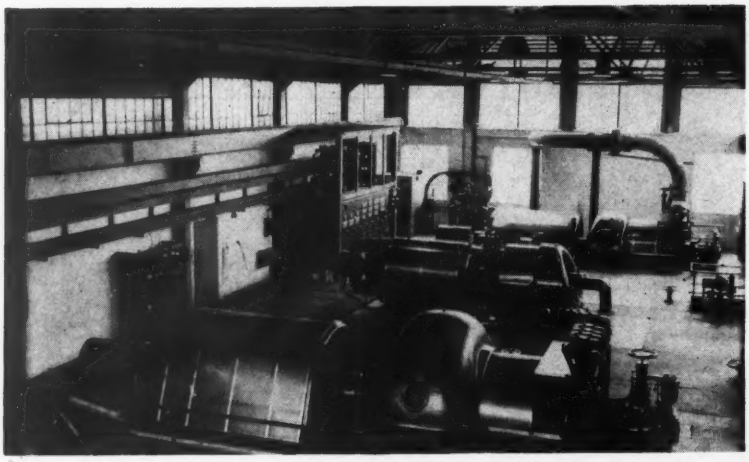
To illustrate the application of these rules, let us analyze the operation of several principal classes of industrial equipment which are common to many diversified industries.

Steam Turbines

Turbo-generator sets, as is the case with most electrical equipment, are exceedingly reliable and will give constant trouble-free operation day in and day out, month after month, and even year after year, with little cause for major repairs, if a simple operating routine is regularly followed.

One of the most essential features to watch, as all experienced turbine men will agree, is the condition of the turbine glands. Wear and maladjustment of these parts can take place very gradually through a period of time without detection. Gradual leakage of blow-by steam and condensate along the turbine shaft into the bearing pedestals and lubricating system will cause a build-up of moisture in the circulation oil. Small amounts of water, even in quantities of 1 per cent. can cause the formation of emulsion and liver-like sludges, which accumulate over oil screens, through sumps, oil storage tanks and the oil circulation system. The oil flow may be seriously impeded or restricted. In severe cases where excessive quantities of moisture are present, bearings may be burned out, or the correct functioning of the governor system threatened. Moisture and water vapors lead to rusting of the circulation system or governor parts. Iron oxide in the lubricating oil acts as a powerful catalyst in hastening oil deterioration, increase in organic acidity and dangerous sludges.

Sludges become less soluble in an oil as the temperature decreases,



With correct lubrication modern steam turbo-generator sets will give long continuous trouble free service

and for this reason they settle out rapidly in the cooler parts of the system. Oil cooling coils become coated with a layer of sludge and emulsion. This film acts as a heat insulator and interferes with proper heat transfer. An elevated temperature of as little as 20 deg. F. of the circulating oil greatly accelerates oil oxidation and the life of the entire batch of oil may be reduced as much as 50 per cent.

Stray electrical leaks in the generator or exciter cause electrolysis of the oil. When this phenomena occurs, the current as it flows from the shaft or bearing carries off with it small particles of metal, which are either deposited on the metal surface representing the opposite pole, or become entrained in the oil stream. Moisture in the oil stream is broken down by electrolysis and oxygen is released in the nascent state. In this form it actively attacks the oil and sludges are rapidly formed. Therefore, it is evident that insulating materials should always be installed between bearing pedestals and the bedplate to prevent the flow of stray currents.

Excessive pressures carried on the lubricating oil system cause the oil to rush into bearing reservoirs or through relief valves at high velocity. This encourages aeration and foaming and rapid oxidation. It has been found that in lubricating systems where efforts are made to restrict the entry of air into the oil that its life is increased by several hundred per cent.

Oil storage tanks should always be vented. This prevents escape of water vapors which would otherwise condense on the underside of the tank covers and drip back into the oil, carrying dirt and rust along with them. In war plants a potent means of sabotage is the addition of small percentages of iron oxide or metal filings. Excessive oil sludging is the immediate result. All oil, no matter how high its quality, or irrespective of whether or not it contains chemical inhibitors, is subject to gradual oxidation and contamination with foreign impurities. It is for these reasons that a periodic check-up on its condition in the chemical laboratory is a valuable service to the power plant engineer. It is a safeguard against a sudden sludging condition, loss of bearings and turbine outage.

Summarizing much of the above then, and suggesting an operating routine which will prevent major repairs and the loss of power production in the factory or plant straining for rapid production of defense equipment, the following program may be instructive:

1. Maintain turbine glands and seals in excellent condition.

2. Maintain a daily log of oil temperatures in and out of the cooler. There should always be a heat loss of approximately 20 deg. F. Sludge on the inside of oil cooler tubes or scale on the outside should not be allowed to accumulate.

3. Insulate bearing pedestals to safeguard against electrolysis.

4. Vent oil storage tanks.

5. Check manufacturer's recommendations to be sure that oil pressures and temperatures are being carried at the proper point.

6. Prevent localized hot spots in the oil circulation system.

7. Purify the oil either continuously or periodically by a centrifuge, filter or batch settling method. Check its condition periodically in the chemical laboratory. (This service is usually rendered without charge by the oil supplier.)

8. Use a high quality turbine oil purchased from a reputable supplier.

Selection of Lubricant for Steam Turbines

A popular misconception which has existed since the early days of the petroleum industry is that a lubricant can be selected on the basis of its physical specifications. The inaccuracy of this procedure is due to the fact that the performance value of an oil is related to its chemical composition, and only in a general way to its physical properties. The chemical make-up of an oil is exceedingly complex, as millions and billions of molecular structures constitute each drop of lubricant. The architectural structure of the molecule is related not only to the number of carbon and hydrogen atoms in combination, but also to the form in which the combination takes place. It is this chemical make-up of the oil which governs:

(1) Its stability in service, i.e., its resistance to oxidation, with the resultant formation of organic acids and sludges.

(2) Its corrosive tendencies.

(3) Its oiliness characteristics.

(4) Useful length of its service life.

The chemical composition of a lubricant is governed by the following:

(1) Type of crude from which oil is refined.

(2) Type of refinement.

(3) Degree of refinement.

(4) Presence or absence of chemical addition agents.

Thus two different oils may have the same or similar viscosities, flash and fire points, colors, neutralization numbers, gravities, pour points, etc., and still be very different chemically.

To illustrate this difference between an oil's physical specifications and its chemical composition, let the reader assume for a moment that he intends to hire a man for a job. The applicant is not selected on the basis of his physical characteristics, i.e., color of hair, eyes, complexion, weight or height, but instead, because of those more intangible character traits, such as ambition, honesty, loyalty, intelligence and congeniality.

Thus, the lubricants buyer in the purchase of the most suitable oil for a turbine should lean heavily upon—

(1) The integrity of the manu-

facturer from whom he purchases his lubricants.

(2) The advice of the equipment builder.

(3) His own experience with lubricants on similar equipment.

(4) The proven service value of the oil.

If all of these factors have been duly considered, then the following physical specifications will cover approximately the further suitability of the lubricants in question:

(1) For direct connected turbines which are lubricated by a circulation system:

a. Viscosity at 100 deg. F—140 to 170 in.; at 210 deg. F—40 to 50 in.
b. Gravity—24 to 30.
c. Flash—360 to 410 deg. F.
d. Fire—380 to 450 deg. F.
e. Pour Point—5 to 15 deg. F.
f. Color—1 to 3.
g. Carbon Content—0.01 to 0.05.
h. Neutralization Number—0.0 to 0.005.
i. Additive—Optional.

(2) For indirect connected turbines where gearsets coupling turbine and generator are lubricated on same circulation system as bearings:

a. Viscosity at 100 deg. F.—280 to 325 in.; at 210 deg. F.—47 to 55 in.
b. Gravity—24 to 30.
c. Flash—370 to 430 deg. F.
d. Fire—390 to 460 deg. F.
e. Pour Point—0 to 15 deg. F.
f. Color—1 to 3.
g. Carbon Content — 0.05 to 0.20.
h. Neutralization Number — 0.005 to 0.02.
i. Additive—Optional.

(3) Turbines with Ring Oiled Bearings:

1. Temperatures between 125 deg. F. and 140 deg. F.
   a. Use same product described under No. 1. Direct connected turbines with circulation systems.
2. Temperatures between 140 deg. and 180 deg. F.
   a. Viscosity at 100 deg. F.—600 to 750 in.; at 210 deg. F.—55 to 65 in.
   b. Gravity—24 to 30.
   c. Flash—400 to 460 deg. F.
   d. Fire—420 to 500 deg. F.
   e. Pour Point — 0 to 20 deg. F.
   f. Color—1 to 5.
   g. Carbon Content—0.01 to 0.65.
   h. Neutralization Number —0.005 to 0.01.
   i. Additive—Optional.
3. Temperatures above 180 deg. F.
   a. Viscosity at 100 deg. F.—1500 to 2500 in.; at 210 deg. F.—85 to 125 in.
   b. Gravity—23 to 29.
   c. Flash—450 to 510 deg. F.
   d. Fire—480 to 570 deg. F.
   e. Pour Point—5 deg. F. to 30 deg. F.
   f. Color—3 to 6.
   g. Carbon Content—0.50 to 1.25.
   h. Neutralization Number —0.01 to 0.03.
   i. Additive—Optional.

(To be continued.)

40,000-Hp. Motor Drive for Army Wind Tunnel

Propeller assemblies for the new wind tunnel for testing large size airplane parts and models at Wright Field are driven by a 40,000-hp. variable speed motor, the largest of its kind ever built. The features of the installation described here were covered in greater detail in a paper by A. M. Dickey, C. M. Laffoon and L. A. Kilgore before the A.I.E.E. Winter Convention in New York City in January

THE NEW WIND TUNNEL of the U. S. Army Air Corps, Dayton, Ohio, soon scheduled for operation, will enclose wind velocities of 400 m.p.h. and greater for testing large size airplane parts and models. The air is to be circulated by two propeller assemblies mounted on a common shaft and operated in series to produce the necessary high pressure. The propeller assembly is driven by a Westinghouse 40,000-hp. variable speed, wound-rotor type induction motor, which has a top rotational speed of 300 r.p.m. (327 r.p.m. synchronous speed), and is the largest unit of this type built to date. It is essential in this application to obtain close speed regulation over a wide speed range.

The Wright Field wind tunnel is designed with a cross-section sufficiently large to accommodate full-size plane sections or parts, and large size complete models, with wind velocities of 400 m.p.h. or greater. Since the output from the motor is eventually absorbed by the circulating air, it is obvious that

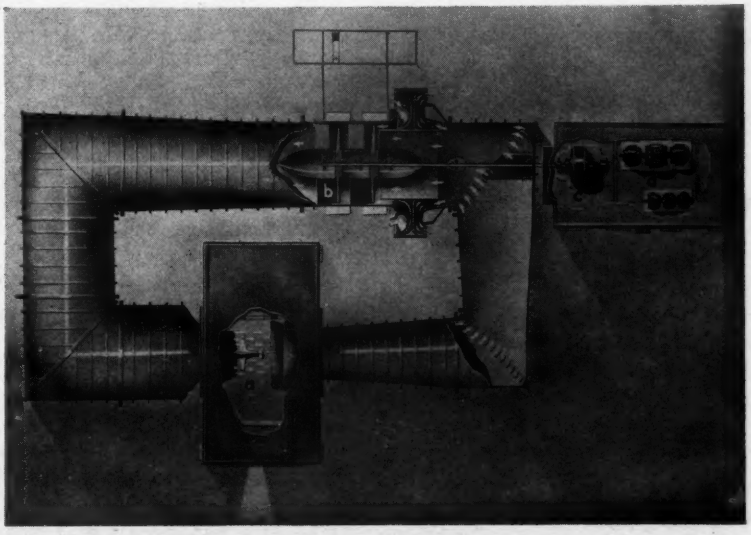


Fig. 1. Plan view of the Wright Field wind tunnel. Air is circulated in a counter clockwise path through the test section (a) at the propellers at (b) which are turned by the motor (c) through a long shaft. The motor generator sets for power recovery and speed control are at (d)

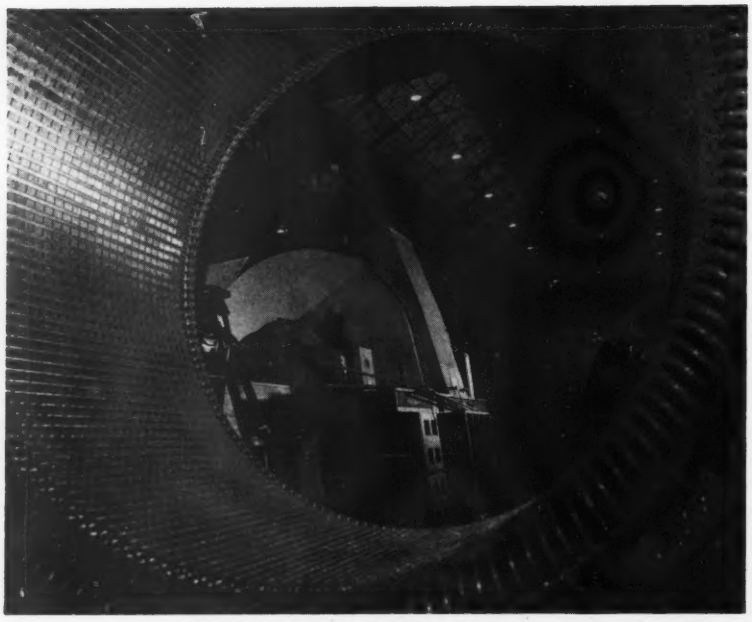


Fig. 2. Closeup of the stator in the 40,000-hp. motor used to drive the 40-ft. propellers which produce a wind of 400 m.p.h.

the temperature of the air would continue to rise until the rate of heat loss dissipated by the tunnel became equal to the rate of input to the air, if complete recirculation were used. When operating under full-speed conditions with 40,000-hp. motor output, the air temperatures would become excessive and it is thus necessary to resort to partial circulation. Sufficiently large inlet and outlet openings are provided at appropriate sections of the tunnel so that approximately 30 per cent make-up air is provided and the gas temperatures kept down to tolerable values. Each of the two-stage propellers which circulate the air has 16 wood blades, approximately 40 ft. in diameter at the tips. The propeller assemblies, including rotating blades, supporting hubs, and stationary guide vanes, were designed by the Air Corps engineers at Wright Field. The general arrangement of the tunnel and propelling equipment is as shown in Fig. 1.

Driving Equipment

The largest wind tunnel in operation at the time the Wright Field wind tunnel was originally planned, had two 4000-hp. driving motors (8000 hp. total). A wind tunnel requiring five times as much driving power was a large step forward. It was also desired to use a single driving motor in order to avoid possible difficulties in assembly and complications in the operation of the equipment. Although a 40,000-hp. wound-rotor induction motor had not been heretofore contemplated, the electrical manufacturers had no misgivings in regard to the feasibility of building it, on account of the fact that synchronous motors of much greater capacity had been built for both 300 and 600 r.p.m. The motor characteristics—power factor, starting kv-a., and speed control, were influenced to an appreciable degree by conditions associated with and requirements of the main power supply system. In order to maintain speed practically constant at any value over a wide speed range with minimum energy requirements, a speed control system was chosen which provided for returning the power from the rotor of the main induction motor to the a.c. supply system. The main rotating auxiliary equipment required to accomplish this result consists of two a.c., d.c. motor generator sets. The a.c. elements of both sets are salient-pole synchronous units with d.c. excitation.

In one set, the a.c. motor receives its power supply from the rotor of the main drive motor, and operates as a synchronous machine at the slip frequency over the entire speed range of the main motor. The second set has the a.c. generator electrically connected to the 60 cycle main supply system, and operates at constant synchronous speed.

Starting and Operation of Equipment

The unit can be started either from the main driving motor or from the a.c. element of the constant speed motor-generator set. When starting from the main motor, no excitation is to be provided for the d.c. and a.c. elements of the auxiliary sets. When power is applied to the stator of the main motor, the rotors of the main motor and variable speed set start to roll and accelerate in speed. The speed reached by the rotor of the main motor will be relatively low due to the fact that the output of the main motor rotor winding is limited primarily to the losses of the variable speed set. The speed of the variable speed set will be relatively high, for its speed is determined by the slip frequency of the main driving motor. If excitation is applied to the field of the a.c. element of the variable speed set, it will pull into synchronism with the rotor of the main motor. The constant speed set can then be started from either the d.c. or the a.c. end. If started from the d.c. end, it will be necessary to synchronize the a.c. end with the main power supply. When the constant speed set is started from the a.c. end, it is necessary to adjust the excitation of the d.c. elements of both sets, so that there will be no appreciable interchange of d.c. power. When starting the main drive from the a.c. end of the constant speed set, the stator of the main motor should be left on open circuit; the connections for the remainder of the equipment should be normal, and the excitation of the two d.c. units adjusted so that the d.c. element of the constant speed set delivers power as a generator to drive the d.c. element of the variable speed set as a motor. Both sets are then brought up to full synchronous speed in the conventional manner. The rotor of the main motor remains at standstill and the voltage induced in the stator has the same frequency as that supplied to the rotor. The excitation of the a.c. and d.c. elements of the variable speed set are then adjusted so that the voltages of the main motor stator are in synchronism with the voltage of the supply system. When the voltages have the same magnitude, frequency, and have approximately correct phase position, the main motor supply switch can be closed without the interchange of an ap-

preciable amount of power between the main motor and the supply system.

There is thus no flow of power between the rotor of the main motor and the stator of the a.c. element of the variable speed set, and hence no torque is produced to accelerate the rotor. By increasing the excitation of the d.c. end of the variable speed set, its speed will tend to decrease and its voltage increase so that it functions as a generator and supplies power to the d.c. end of the constant speed set. This power is then returned to the supply system by the a.c. element of the constant speed set. At the instant the speed of the variable speed set starts to drop, the initial angular displacement between its voltage and the voltage of the main motor rotor winding produces a secondary current which reacts with the magnetizing flux to produce a motor torque to turn and accelerate the rotor. As the speed of the variable speed set decreases, the speed of the main rotor increases and both elements maintain synchronism at the slip frequency of the main motor.

Either of the two methods of starting is practical and satisfactory. The method of starting from the relatively small constant speed set was adopted due to the fact that less complication is involved in the starting equipment and less shock to the supply system occurs.

William DuBois Duddell

IT IS HIGHLY probable that the world's present knowledge of electrical phenomena, especially that of alternating currents would not be nearly as complete without the results obtained by the use of a highly important instrument, the oscillograph. This instrument was the first and most notable invention of William Duddell.

This little biography of William Duddell appeared in a recent issue of the Ohmite News issued by the Ohmite Manufacturing Co. of Chicago, but it is of such fundamental interest to all users of electrical instruments that we are glad of the opportunity of reprinting it here.

William Duddell was born in England in 1872, but because of delicate health, he was educated in Cannes, France. As a child he showed great mechanical ingenuity, and, after his schooling, he served an apprenticeship as an engineer at Colchester. In 1893 he went to the City and Guilds Institute where he stayed for several years because of the excellent facilities for experimental work. Later he opened an office of his own in Victoria Street, London.

The present day recording oscillographs of the galvanometer type all utilize the same basic principles incorporated in the first recording oscillograph developed by Duddell in 1894. The device, which is illustrated above, consists of a modified moving coil galvanometer combined with a rotating or vibrating mirror and a moving photographic film or plate. Briefly described, the galvanometer or vibrator portion consists of two parallel conductors made of thin phosphor bronze looped over a pulley. A very small mirror is attached to both strips of phosphor bronze. The assembly is mounted between the poles of a powerful magnet. A guide block placed at the top of the pole pieces limits the vibration of the conductors to the portion directly in the magnetic field. When a current is passed through the strips, one strip advances while the other recedes thus causing the mirror to rotate about a vertical axis.

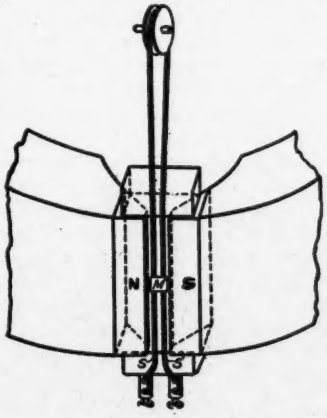


Fig. 1. Vibrator in Duddell Oscillograph

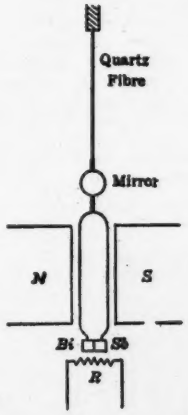


Fig. 2. Duddell Thermo-galvanometer

The entire vibrator is immersed in oil, the purpose being to damp its movement. A source of light is arranged so that the beam is reflected by the mirror to a photographic film or plate. When an alternating current passes through the strips, the mirror, and therefore the spot of light from the reflected beam, oscillates back and forth as the current varies. When the photographic film is moved at right angles to the direction of motion of the spot of light, an image of the alternating current wave form results.

In 1904 Duddell saw the need for a sensitive alternating current galvanometer for current measurement at radio frequencies and adapted the Boys' radio-micrometer for this purpose. The moving system of the Boys' instrument consisted of a single turn of silver wire at the bottom of which was a tiny thermocouple of bismuth and antimony. This unit was suspended between the poles of a strong magnet by means of a fine quartz fibre, to which was attached a small mirror. Deflections were read with a lamp and a scale. Duddell's contribution to this instrument was the addition of a heating unit mounted just under the thermocouple (see illustration). The current to be measured passes through the heating resistor and the heat developed is carried to the thermocouple by convection and radiation. The current generated by the thermocouple flows through the silver loop which is deflected by electrodynamic action. The modern thermo-galvanometer is more stable in operation because the heating unit is in direct contact with the thermocouple. The indications of the instrument are proportional to the square of the current, and, beacuse it is practically free of inductance, it may be used to measure current at high frequencies.

Duddell's contributions to electrical science were widely recognized and he held office in several learned societies, besides being a Fellow of the Royal Society. He died on November 4, 1917.

A.S.M.E. Discusses Production and Maintenance

STARTING early on Monday morning with simultaneous sessions on aviation, flame hardening and plastics, the Semi-Annual Meeting of the American Society of Mechanical Engineers held in Cleveland, O., left no open period during the entire three days from June 8 to 10. With approximately 1000 in attendance, nearly all with new problems confronting them in the production of war materials, there was an exchange of ideas which was conducive to helpful discussions.

Engineers are thoroughly convinced that although equipment alone cannot win the war, the soldier in the field, on the water or in the air must be provided with every advantage that American science, engineering and production can get to him, and it was along these lines that thoughts were directed during the luncheon periods and the banquet held Tuesday evening.

On Monday Edwin B. Newton, director of technical service of the B. F. Goodrich Co. dealt with the part rubber is taking in the conduct of the war. Tuesday William B. Stout, president of the Stout Engineering Laboratories of Dearborn, Mich., painted a word picture of what may be expected in the aviation field during the near future. At the banquet, James W. Parker, vice-president of the Detroit Edison Co. and president of the A.S.M.E. outlined his thoughts on the duties of engineers during this war period, and was followed in the program by Sir Louis Beale of the British Supply Council in North America. In his opinion, the United Nations have won the battle of production, are winning the battle of transportation and will win the battle of combat. Americans are now fighting with equipment equal to that of the enemy—with a courage, a skill and brain work that make the final result certain. He urged industrialists, technicians and war workers to hold fast to the doctrine that free people, working in free counries, could outproduce the slave labor of slave countries.

Nominations for 1943 officers of A.S.M.E. were announced as: President, Harold V. Coes, Vice-President, Ford, Bacon & Davis, Inc., New York, N. Y.; Vice-presidents, Joseph W. Eshelman, Thomas E. Purcell, Guy T. Shoemaker, Walter J. Wohlenberg; Manager, Roscoe W. Morton, Albert E. White, and Alexander R. Stevenson, Jr. Next year the Semi-Annual meeting will be held in Los Angeles, Calif.

Round-Table Discussions

Conservation, reclamation and substitution in aircraft and aircraft parts manufacture were subjects discussed at a round-table session conducted under the able leadership of F. C. Crawford who maintained a live interest in the subject by having the ideas of leading manufacturers presented by over thirty engineers or other representatives qualified to give details of the ideas put into practice.

Fig. 2. Harold V. Coes, nominated for A.S.M.E. President in 1943

In the second of these round-table sessions, power plant problems of current interest were discussed under the chairmanship of R. M. Van Duser, Jr., of the Detroit Edison Co.

So varied were the opinions regarding the causes and prevention of soot and slag on boiler heating surfaces that no specific conclusions could be drawn. Where, however, unsatisfactory operation along this line is experienced, the general opinion was that improved combustion conditions are required.

Ammonia in feedwater came up for discussion and the opinion was expressed that ammonia attacks the copper, brass and bronze it contacts in the feedwater lines but does not damage the ferrous metals. The dissolved copper carried into the boiler has a tendency to deposit in corroded pits and crevices in the boiler metal but no evidence is available to indicate that these deposits cause corrosion of the boiler shell or tubes.

Operators seem to be agreed that steam turbines should be inspected after about six months of their initial operation. Beyond that period, they may run for 6000 to 10,000 hr. between inspections though many units are run for years without being overhauled. One of the most prevalent causes of outage is the accumulation of sediment deposited on the turbine blades.

Some operators establish periods for routine inspection, others wait for indications that the unit

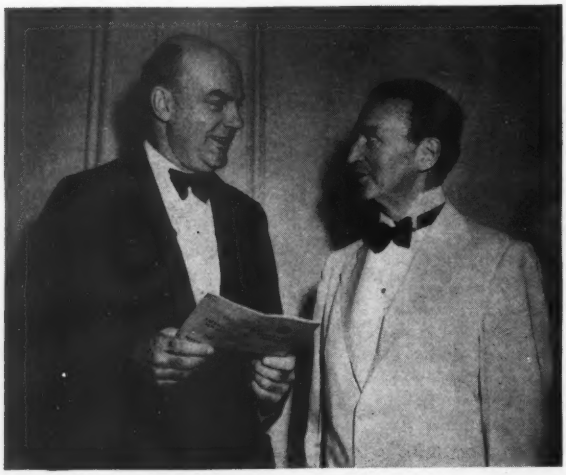


Fig. 1. James W. Parker, A.S.M.E. President, and Sir Louis Beale of the British Council of North America, were the principal speakers at the banquet

needs special attention to bring it up to normal efficiency. Supervisory instruments have been found helpful in lengthening periods of operation which were reported as varying from one to three years. Expansion of turbine parts should be checked carefully at times of inspection, according to one operator.

Application of jets of air over the fuel bed in boiler furnaces started many years ago principally as a means of eliminating smoke, but in addition some of these applications have proved an aid to combustion, as was brought out by H. C. Carroll in his paper on Modern Applications of Overfire Air.

Modern practice points to the use of high pressure air jets, supplied by power driven fans, applied in furnaces to provide turbulence to prevent stratification; to increase heat releases in furnaces of limited volume; to effect economically increased steam production; to replace refractory arches designed to mix lean and rich gases; to reduce the combustible in the fly ash when coal is burned in suspension; and to burn refuse more rapidly and smokelessly.

In order to carry out his studies of this problem, the author developed a modified laboratory gas analyzer that could be taken to the power plant and there used to measure carbon dioxide, oxygen, hydrogen, carbon monoxide and methane with laboratory precision. With the aid of this instrument he was able to show, in one application to an underfeed stoker, that the total heat loss due to unburned gases was reduced from 4.42 per cent to 0.84 per cent by the application of overfire air from the plenum box.

Prevent Smoke and Reduce Waste S. P. A. Theme

THROUGHOUT the entire meeting of the Smoke Prevention Association of America held in Cleveland, O., from June 2 to 5, the thought evident in the minds of the speakers was "America is at war, our services are at the call of the Government."

It was in this spirit that Thomas J. Thomas, associate director in charge of bituminous coal in the Office of Solid Fuels Coordination addressed the opening session. In the same spirit J. W. Barkley of the Bureau of Mines at one of the closing meetings led a discussion on how smoke departments can coordinate their activities with the Government's efforts to aid the war industry by making available their knowledge and experience with fuel-burning equipment in carrying out the technical side of the general program. And the same theme pervaded all sessions.

On the statistical side, Mr. Thomas said that coal provided more than 80 per cent of all fuel used by the railroads, over 70 per cent of the fuel used for generation of electricity by the public utilities, and approximately 75 per cent of the power and fuel used for the operation of general manufacturing.

It would be a contribution well worth making if everybody who uses coal would practice known conservation methods as has been done by many of the industries. For example, in 1921, the railroads required 162 lb. of coal to haul 1000 gross tons one mile; this was reduced to 111 lb. in 1941, a saving of 32 per cent, or 30,462,504 tons per year. Electric utilities have been outstanding in conservation of fuel having reduced their requirements from 3.39 lb. per kw-hr. in 1920 to 1.34 lb. in 1941, which represented a saving of some 97,588,146 tons or 60.2 per cent compared with 1920.

Describing in great detail a study of atmospheric pollution made recently in metropolitan New York, W. F. Davidson of the Consolidated Edison Co. presented data collected in a survey undertaken to determine the extent to which dust emitted from the chimneys of power houses and gas manufacturing plants within the city contributed to the general atmospheric pollution of the city. Variations from day to day and hour to hour, he reported, are often very large and have no simple explanation. Results reported, however, suggest that there may be a useful correlation between wind velocity and shade number. There is a clearly indicated relation that the shade number (dust concentration) varies inversely as the square-root of the wind velocity.

"Experience with the survey," Mr. Davidson said, "has emphasized the extreme complexity of the atmospheric pollution problem, and it has also shown how incompletely many of our ideas are formulated."

The Chimney Problem

In discussing chimney performance and its relation to the smoke problem, J. G. Mingle stated that, insofar as the chimney is concerned, the reason for the production of objectionable smoke is the inability of the chimney to produce sufficient available draft to overcome the total dynamic draft. Consequently, the chimney is forced to operate at a reduced capacity which, in turn, diminishes the required air supply for the combustion process. The operation of present chimneys can be improved by a prorating of the air supply through the fuel bed and into the combustion chamber which will diminish the total dynamic draft, and, as a result, will enable the chimney to deliver more gases.

Diesel engines, particularly those used for driving locomotive and automotive vehicles are coming into such prominent use as to invite the attention of smoke abatement engineers to study their contribution to city air pollution and prevention methods. This problem was discussed by René J. Bender of the Sinclair Refining Co. who made the assertion that the exhaust gases of a Diesel engine will contain no visible smoke nor any offensive invisible products provided the engine is maintained in a satisfactory mechanical condition, the correct Diesel fuel is used and the operator handles his engine controls correctly. He gave as the three fundamental requirements of smokeless combustion: Correct proportion of fuel and air, correct temperature, and correct mixture of fuel and air.

A considerable portion of the program was given over to the discussion of domestic heating problems and topics of special interest to railroad engineers.

The newly elected officers for the coming year are: Arthur E. Hutchinson of Cleveland, president; W. E. E. Koepler of Bluefield, W. Va., first vice president; George P. Kenworthy of Decatur, Ill., second vice president; and Frank A. Chambers of Chicago re-elected secretary-treasurer. Next year the meeting will be held in Pittsburgh.

The Oil and Gas Power Conference at Peoria

THE 15TH NATIONAL Oil and Gas Power Conference was held June 17 to 19 at the Pere Marquette Hotel, Peoria, Ill. This year this conference was held jointly by the Oil and Gas Power Division of the A.S.M.E. and the Diesel Engine Division of the Society of Automotive Engineers. As a consequence of this combined sponsorship, the meeting was unusually well attended, over 400 having been registered. The Conference included an exhibit at which many of the late developments in the internal combustion engine field were displayed by some 27 manufacturers. A feature of great interest to everybody at this exhibit was a captured Mercedes-Benz aircraft engine loaned by Wright Aeronautical Corp. This engine was removed from a Messerschmidt pursuit plane shot down over England in 1939.

Due to the restrictions imposed by war, the inspection visits to manufacturing plants which usually form an important feature of these conferences, had to be omitted. Peoria is the home of the Caterpillar Tractor Co. as well as other important manufacturing concerns and while no visits could be made to the factory, Caterpillar did however stage a demonstration of its Diesel powered equipment at the East Peoria Proving Ground. This provided an unusual opportunity to observe modern large-scale Diesel powered dirt moving equipment in action. Combined with an Old-style Illinois Fish Fry on the last afternoon of the meeting, this proving ground demonstration provided an enjoyable climax to a well organized, well balanced technical conference.

Round Table

The technical program comprised three joint sessions of the A.S.M.E. and S.A.E. and one each of the A.S.M.E. and the S.A.E. A round table conference by the two societies, on operation and maintenance under wartime conditions, provided an opportunity to exchange views in regard to various operating problems and as could well be expected, was very well attended. An interesting result of this joint conference was that despite preconceived notions, when considered in a joint session such as this, the respective problems of the slow speed, heavy duty engine group and of the high speed engine group proved not to be essentially different. Neither side could produce types of troubles which the other side had not experienced in one way or another.

Bearings and Joints

Aside from a very interesting address on the Mercedes-Benz aircraft engine already referred to, by R. W. Young, Chief Engineer of Wright Aeronautical Corp., the first joint session involved two other papers, one on Bearings for Diesel Engines by A. B. Willi, Chief Engineer of the Federal-Mogul Corp. and the other entitled "Load Relations in Bolted Joints" by Prof. T. J. Dolan of the University of Illinois.

Mr. Willi's paper on Bearings for Diesel Engines was very complete and included important data on the composition and characteristics of various types of bearing metals that should be of distinct value to both operators and designers of Diesel engines. Among other things which Mr. Willi particularly emphasized was the fact that surface discoloration of a bearing, while it may indicate corrosion in some cases, in many others it is quite harmless. Thousands of bearings, he pointed out, are wastefully discarded because the surface is discolored, this discoloration being incorrectly diagnosed as corrosion or something harmful.

The session on Power Plants included a paper on heat recovery from Diesels by F. P. Grutzner of Fairbanks, Morse & Co., and one on closed cooling systems for Diesels by J. W. Bostwick also of Fairbanks Morse. A paper on the Design of Internal-Combustion-Engine Power Plants by G. C. Boyer of Burns & McDonnell outlined briefly some of the features involved in modern Diesel practice.

Although not specifically a Diesel engine problem, the most interesting paper presented at this session was one by a young Danish engineer, Mr. Troels Warming, now mechanical engineer for Nordberg Mfg. Co. His paper was entitled Power Pulsations between Synchronous Generators. This subject, it is quite obvious, is an electrical one but it is more closely associated with Diesel than with other types of plant operation.

The final technical session on Friday morning was devoted to the general subject of engines and combustion and was a joint session of the A.S.M.E. and the S.A.E. Of special interest at this session was a showing of the N.A.C.A. film on detonation phenomena. By means of a specially designed quartz window fitted in the head of a Diesel engine it had been possible to take motion pictures of the actual combustion of the gases in the cylinder. The pictures were taken with the Edgerton high speed motion picture camera at a rate of 2400 frames per second. It was exceedingly interesting to be able to observe the propagation of normal combustion across the cylinder but still more interesting was the detonation at the end of the combustion cycle that denoted knocking.

Dr. E. W. Landen of the Armour Research Foundation of Chicago and Dr. L. A. Blanc of the Research Department of Caterpillar Tractor Co., presented a paper at this session on the subject of instrumentation in the study of Diesel combustion. This paper described the "window technique" developed for the optical study of combustion. In this system a quartz port is introduced into the cylinder wall through which, for example, a spectrograph may be used to observe the flame.

Diesel Smoke

The effect of Diesel fuel on exhaust smoke and odor was covered rather comprehensively in a paper by R. S. Wetmiller, Mechanical Engineer, Beacon Labs., Texas Co., and Lt. L. E. Endsley, U. S. Army Engineers. This paper, necessarily, was quite involved but the study indicated that while fuels may be chosen to give desired results it is not possible to obtain all desirable results with a single fuel, at least not without recourse to additives. For example, an increase in cetane number or volatility will reduce exhaust smoke and an increase in cetane number will reduce exhaust odor but an increase in either of these properties is accompanied by decreased power and economy.

In this brief report of the meeting it is not possible to comment on all of the papers presented but there was sufficient variety among them to hold something of interest for every one attending regardless of his specialized interests.

The PRACTICAL ENGINEER and ELECTRICIAN

RICHARD H. MORRIS, EDITOR

PRACTICAL COAL STORAGE

WITH 24 p. devoted to this subject elsewhere in the issue, another 1000 words would be superfluous except for the universal importance of this problem at the present time. Proper coal storage is simple even though proper equipment and adequate storage areas are not available.

First, the ground should be well cleared. If muddy, a thin cinder fill may be used, but this should be well sealed on the edges and the coal pile should overlap it to avoid air leakage through the cinder bed.

Second, the coal should be stored in layers from 2 to 3 ft. deep, avoiding segregation as much as possible, or if that cannot be done remixing as the layer is put down.

Third, compact each layer, to increase the density and reduce air circulation. A tractor is ideal for this, but sluicing with water is also effective.

Fourth, seal all slopes, edges, junctions with walls, etc., thoroughly with a thick layer of dirt, fine coal or bitumen. These are danger points. Also crown the top so it will drain uniformly without cutting gulleys during rain storms.

Fifth, watch carefully for undue heating, especially during the first 3 mo. Temperature readings are useful and readings of over 150 deg. F. are dangerous. Hot spots can usually be detected on humid mornings by the presence of a slight mist or fog, in winter by uneven melting of the snow.

Hot spots can sometimes be smothered by recompacting and sealing with fine coal. They cannot be cooled with water unless the entire pile can be submerged to stop all air flow. As a rule it is best to dig them out and use immediately or spread in a very thin layer to cool before repiling. Do not start a new pile against an old one, the junction is almost impossible to seal properly.

CONTENTS

Condenser Retubing Pays. By J. B. Cotter 94

Pals. By L. Kelly 95

How to Increase the Life of Rubber Hose 95
By S. H. Coleman.

Management and Maintenance 96
Personnel Managers or Personnel Safety Engineers. By J. C. De Foe.
An Effective Way to Control Maintenance Costs. By John P. Simons.
An Educated Stooge Is Not a Rival. By John Tooker.

Mechanical Power 97
Fats and Oils Affect Belt Materials.
Belt Slip. By W. F. Schaphorst.

We Reset a Boiler. By B. H. Whitehouse 98

Questions and Answers 100
Drying Air by Refrigeration.
Substitute Materials.
His Exciters Hunt.
He Wants Air Filters to Last Longer.
Slag and Spalling Mean High Furnace Maintenance.
Steel Tubes for Heater Replacements.
How to Figure Tonnage of a Brine Cooler.
How Can Short Circuits In Underground Cables Be Located?
What Is the Collapsing Pressure of a Condenser Tube?
How Can He Prevent Carryover?
Engineer Needs Help on Record Forms.
What Determines Lead?
Another Question About Power Factor.

Letters and Comments 105
License Frames.
Accurate Marking for Calibrated Gages.
This Can Be Used On Right Hand Models Too.

How Would You Do It? 106

Welding Tricks. By A. F. Davis 108

Bill Otto's Emergency Page 109

Shaft Straightening with the Blowpipe. By A. B. Gordon 110

Conservation Control Cards for Tools 112

Shop Talk 114

The War Program 116

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago. Ill.

Condenser Retubing Pays

Surface condenser retubed with belled inlets and flush type ferrules shows an increased vacuum of 0.66 in. due to better heat transfer and more circulating water because of lowered friction loss in the water boxes. Flattened brass pipe installed between tubes prevents vibration in the tube sheet supports

By J. B. COTTER*

WHERE SURFACE condenser tubes are somewhat old and considerably dezincified, it has been proven, by actual experience and operating results, that the reasonable step to take, from the standpoint of efficiency, serviceability factor, and production expense, is to replace all the old tubes with new ones, preferably of some alloy better adapted to local conditions.

This has been demonstrated by the recent retubing of a 35,000 sq. ft. vertical surface condenser in a large generating steam power station in which the entire lot of 7425, size 1 in. O. D. by 18 ft. 3 in. long, tubes were replaced.

Old tubes were of Muntz metal and after 17 yr. of service had become badly dezincified, so they were very brittle, and, of course, with the surface film collected over the years were somewhat deficient in heat transfer quality. The new tubes installed were of Admiralty metal.

In the inlet water pass of the condenser the tubes installed were belled on the inlet end, as shown in detail by Fig. 3A. This prevents them from slipping down, although the main objective for belling the tubes was to provide for less entrance resistance to the circulating water. The tube being belled over a lead ring of packing also eliminates air or water pockets in the packing glands in the top tube sheet under the bell.

A flared flush type ferrule, Fig. 3C, was used on the water inlet end of the tubes in the discharge pass of the condenser which the tube rests on and it too reduces water entrance resistance. All tubes were packed with standard packing consisting of lead and fibre rings on each end of all tubes. The lead rings on each end of all tubes provide a perfect bond to the tube sheets to eliminate electrolytic action and possible dezincification in individual tubes.

One of the most important changes made during this retube job was the installation of flattened brass pipe between every other row of tubes, in the three sections midway between the tube sheets and tube support sheets, to prevent tube vibration by placing slight stress on each tube. Figures 1 and 2 plainly illustrate this new method of tube bracing as well as the method of belling and packing the tubes.

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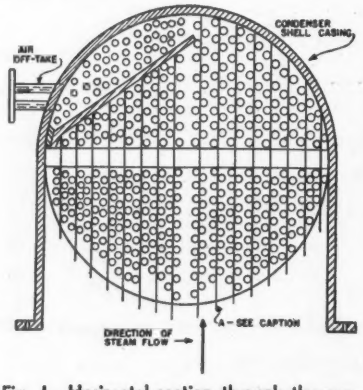


Fig. 1. Horizontal section through the condenser showing how the brass pipe was installed to prevent tube vibration. Note at A that the flattened pipe projects about 4 in. outside of the tube bundle to give sufficient grip for removing the pipe easily when tubes must be repacked

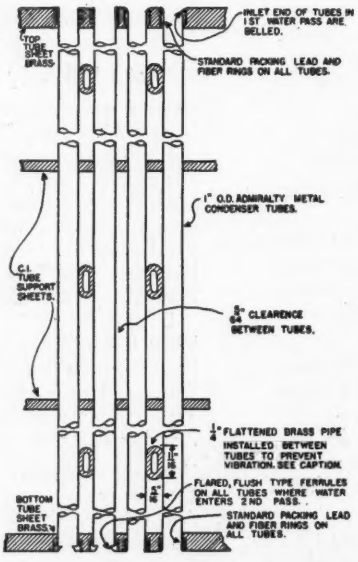

INLET END OF TUBES IN 1ST WATER PASS ARE BELLED.
TOP TUBE SHEET BRASS
STANDARD PACKING LEAD AND FIBER RINGS ON ALL TUBES.
1" O.D. ADMIRALTY METAL CONDENSER TUBES.
C.I. TUBE SUPPORT SHEETS.
CLEARANCE BETWEEN TUBES.
FLATTENED BRASS PIPE INSTALLED BETWEEN TUBES TO PREVENT VIBRATION. SEE CAPTION.
FLARED, FLUSH TYPE FERRULES ON ALL TUBES WHERE WATER ENTERS 2ND PASS.
BOTTOM TUBE SHEET BRASS
STANDARD PACKING LEAD AND FIBER RINGS ON ALL TUBES.

Fig. 2. Showing the method of installing, packing and bracing 1 in. tubes in a 35,000 sq. ft. vertical surface condenser. Details of the glands, packing and stuffing boxes are shown by Fig. 3. Note that for clarity the brass pipe is drawn larger than it actually is. The dimensions given are correct

By actual comparative tests and from results of continuous operation before and after the retubing was completed, the performance of this main unit condenser has been amazing and its efficiency has increased to an almost astounding degree. For comparison of efficiency and performance, water rate tests were run on the turbine-condenser unit prior to, and immediatetly following the condenser retubing with all temperatures and conditions identical during the two test periods.

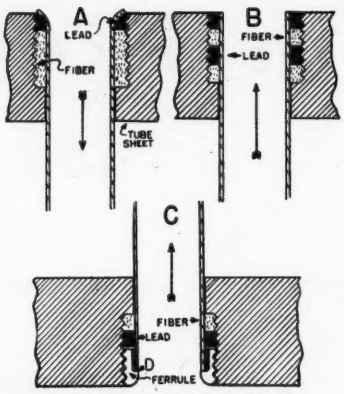


Fig. 3. A. Belled tubes at the entrance (top) to the first pass. B. Exit ends of tubes in both passes (bottom end of first pass, top end of second pass). C. Flared flush type ferrules used on entrance to second pass bottom end. Note the shoulder D that prevents the tube from dropping. Packing on all tubes, lead and fibre rings

Results of the comparative tests showed an actual physical decrease in the absolute exhaust pressure on the turbine of 0.66 in Hg. This gives a savings in steam consumption of 11,750 lb. per hr. when operating the unit at maximum conditions as was the case during the tests. This outstanding improvement in the condenser's performance and efficiency can be attributed primarily to only two major contributing factors.

Table I. Itemized cost of the retubing job described in the text. The condenser was of the vertical type with 35,000 sq. ft. of cooling surface

Tubes	$20,269.00
Ferrules	348.00
Packing	1,277.00
Brass pipe for bracing	146.00
Total material	22,040.00
Labor	1,623.00
Total cost	$23,663.00

First, the better heat transfer coefficient quality of the new tubes. Second, the increased volume of cooling water pumped due to decreased entrance loss of water entering the new tubes with the belled inlet end.

The actual savings realized as a result of this retube job will exceed the total cost of retubing in a very few years' time.

The total cost involved in this major retubing job amounted to $23,663.00, itemized as shown by Table I.

Complete retubing of this condenser, which included all work of removing old tubes, ferrules, packing, etc., and installation of all new tubes, ferrules, packing, and flattened pipe for tube bracing, required only 18 da. or a total of 2016 man hours. This was accomplished by using three 8 hr. shifts each day; four men on the two night shifts and an average of six men on the day shift.

Pals

By L. KELLY

This last month I've been busy
Taking out my old steam pumps.
It's going to be quite lonesome
Without those clickety-bumps.

They used to keep me company
On my lonely watch at night.
They helped me keep my vigil
'Till the dawning day grew bright.

I always set my coffee jug
Upon them when I came.
They kept the Java nice and warm
'Twill never be the same.

Yes, electric pumps are modern
And they do run quietly.
But for good, old-fashioned friendliness
Bring my steam pumps back to me.

How to Increase the Life of Rubber Hose

By S. H. COLEMAN

CONSERVATION of all available supplies of rubber is essential to furtherance of the war effort so industrial rubber hose may not be easily replaceable. Here are 6 ways to slow up its deterioration and increase its service life.

1. Selection of rubber hose should ordinarily be based on the manufacturers' recommendation covering adaptability for specific service requirements. Safety is a most important factor to be considered where steam, compressed air, hot water, or other dangerous fluids are to be handled. In no case should the recommended working pressure of a hose be exceeded.

Except where pressures are very high or internal or external service conditions are very severe, the exterior rubber covering if properly compounded will ordinarily last the life of the hose. Use of wire winding or other form of protective covering, unless absolutely necessary, is not generally recommended, since wear may cause breakage, thus leaving the projecting jagged ends to jeopardize the safety of workmen.

2. Storage procedure plays an important part in the preservation so the choice of a storage space should be dictated by the absence of a number of conditions that accelerate deterioration of both rubber and fabric. These are, namely, moisture, sunlight, high temperatures, and the presence of ozone in the atmosphere.

Moisture or dampness causes hose covered with plain woven or braided cotton fabric to mildew and rot. Sunlight tends to destroy the resiliency of rubber, promoting cracking or checking. Excessive heat hardens rubber and may cause a breakdown of its mechanical structure. Ozone in the atmosphere has a strong oxidizing effect on rubber accelerating its deterioration.

In general, the best storage space is a cool dry room protected from sunlight, high temperatures and ozone concentrations. Hose should never be stored near steam pipes or in boiler rooms. Similarly it is advisable never to place hose near generators or other equipment which give off ozone so that it is important to avoid closed generator or switch rooms.

3. Couplings and the method of their application are important factors affecting the efficiency and life of the hose. Such fittings must be suitable for the pressure and service. Clamps must be designed and applied in such a way that damage to the hose is minimized and an adequate factor of safety assured.

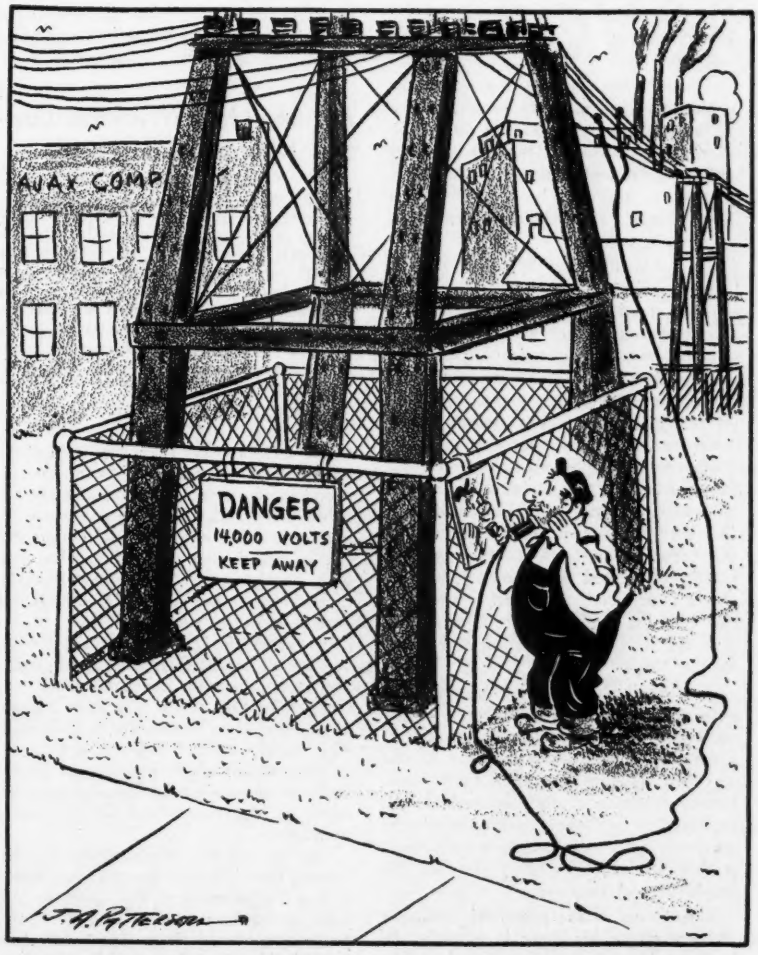
Before installing couplings or fitting that come in direct contact with the rubber covers or tubes of hose, rough edges or burrs that might cut or damage the hose should be filed off. If the fitting fails to go into place easily use common laundry soap or rubber cement as a lubricant. Under no circumstances use grease or oil for this purpose as these materials tend to destroy natural rubber.

4. Kinking or bending a hose sharply, places excessive strain on a single point and may cause serious damage. Under no circumstances should a hose be hung on a nail or the edge of a board. Always coil it on the floor, a shelf or some other flat surface. If it is desirable to hang the hose on a wall or other structural member, coil it on a reel or a large diameter rack. Never fold back any type of hose to stop flow as this practice places excessive strain on the hose walls and may cause it to rupture. Use the valve or nozzle to shut off the flow.

If a wire reinforced or metal lined type of hose is crushed or kinked it is usually rendered unserviceable. Hose with woven wire protection if crushed, however, can very frequently be reshaped by carefully hammering it back into its original cylindrical form, using a mallet or the flat side of a hammer. With any type of hose, though, it is always advisable to prevent their being run over by trucks or other heavy vehicles.

5. Oils and greases, whether mineral or animal, are particularly hard on natural rubber compounds. Unless the hose is constructed of a synthetic rubber designed to resist these substances its external and internal surfaces should be wiped or washed clean whenever it is removed from service for any appreciable period of time.

6. Hot water or condensate from steam has a tendency to swell the inside rubber tube restricting its effective area. To control this tendency all hot water should be drained from the hose immediately after it has been used.



"I haven't had a bum shave since Mr. Gillcush fixed his voltage regulator"

MANAGEMENT and MAINTENANCE

Personnel Managers or Personnel Safety Engineers

By J. C. DE FOE

THE FIRST impression of an organization, regardless of its size, is given to a prospective employe by the Personnel Manager. Actually it may be personnel manager's initial instructions which may chart the entire course of industrial usefulness of a new employe. Hence it is essential that the personnel manager not only pick the outstanding applicants for a job, he must know enough practical psychology (not found in books) to impress on the new employe the importance of safety practices, the necessity of maintaining a high public relation, and that he is an intimate part of a large organization and not just a tooth in a large industrial gear.

When a new employe leaves the office of the personnel manager he should feel the company has a personal interest in his welfare and safety, that his employer will recognize and eventually reward diligent work, and that he must return to his employer a labor-dollar for each dollar-cash he returns.

In too many cases after an employe takes his job the personnel manager loses all contact with him. This seems to be an outstanding fallacy which has dogged so many personnel managers. They are always microscopically investigating new blood to inject into the veins of industry, but many of them fail to realize the old blood can be re-energized by personal contact. The old must train the new, therefore it is absolutely essential that old employes must never be allowed to feel they are not important factors of the organization, and it must be constantly impressed on them by the employer's personal personnel representative that he, the employer, is concerned with the welfare, satisfaction and safety of his "boys."

During the period when co-operation between employe and employer is so essential to War Production it would be a good time to transform many of our so called personnel managers from bookkeepers, insurance salesmen and stenographers, to personnel safety engineers who will act as the employer's Goodwill Ambassador Extraordinary between the employes and employer.

The man with personnel manager written across his door is actually the benchmark in the cross-section of the organization he represents. Public Relations and Employe-Employer Relations of an entire organization may be pleasantly advanced or drastically retarded by his words or actions.

In this rapidly changing world of ours, personnel managers or personnel safety engineers have a golden opportunity to do an outstanding service toward War Production by doing all in their power to bring a better understanding between employe and employer. This can best be accomplished by personal contact between personnel manager and employes, extensive educational programs, for both old and new employes and "down to good earth" office contacts with all who seek the advice of the personnel manager. A good personnel safety engineer will never let anyone, even a newsboy, leave his office without making him feel like he's met the "best guy in the world."

An Effective Way to Control Maintenance Costs

By JOHN P. SIMONS

To cut down overhead on maintenance department equipment use it for producing special parts needed by the company. To insure minimum maintenance costs have the maintenance department bid for the job against outside concerns. To insure quality have the inspectors independent of the maintenance department and outside influences

MAINTENANCE costs are among the hardest costs for plant management to check and be sure they are reasonable. The cost of raw material, steam, operating changes, taxes, etc., can all be established and standardized. Maintenance repairs and other maintenance charges can not be anticipated as readily. An accident, carelessness or even new developments may make otherwise reasonable figures be out of line.

A great deal of maintenance work consists of replacement of special wearing parts, bearings, line shaft work, etc. To handle this work a certain amount of equipment or machinery is necessary. The equipment and machinery that are in the maintenance department represents an investment by the company the same as the investment on productive machines.

As far as the management is concerned, idle time on this equipment means a loss on investment the same as idle time on equipment used in the regular production line of the company.

This idea is different from that held by a good many in the maintenance department when the opinion is often expressed that "if the maintenance department is not working the plant is going in good shape." It is, therefore, the duty of those in charge of maintenance work to find out what the equipment on hand can be used for, particularly, in producing parts or special items which are used by the company.

The maintenance department cannot be given a free hand or there would be no control on costs; therefore, they should be asked to submit figures or bids on the work that is to be done the same as outside firms. This should be handled in the regular way by the Purchasing Department.

This makes it possible for the purchasing agent to assure outside firms that they have a legitimate lower figure, or they can tell the maintenance department that someone else is better equipped to handle the work. This helps to keep the maintenance department up-to-date on both methods and equipment.

Where those in charge of maintenance work can be kept "on their toes," costs can be kept at a satisfactory figure. This condition is best maintained by having those responsible for the work bid on the jobs. This accomplishes several purposes:

First. It insures the figuring of the work at the lowest figure compatible with good workmanship.

Second. It makes the maintenance men realize that they are on a competitive basis with others in the same line.

Third. It necessitates a thorough knowledge on the part of those responsible for the work of exactly what is to be done.

Fourth. It enables a discussion before the work is started of various ways of doing the work, and a selection of the best methods.

Fifth. It does away with the tendency to have fill-in jobs. Incidental advantages are of a general nature, applying to any cost setup. The foreman picks the best men for the job. There are no so-called pickup jobs which the men consider as those used to keep them busy until a rush job comes along. It keeps those responsible for costs, following the workmen closer to see that they turn out a reasonable day's work because they know that they will have to explain any excess labor charges.

Inspection Procedure

The question of inspection may be brought up at this point. The inspection department should not be responsible to the maintenance department. They can thus hold the work done in the shop to the same standard as required by outside concerns.

This does away with any tendency on the part of anyone in the maintenance department to substitute standards of their own in place of those that have been set up for the work. The men knowing the job for which the part is being made might feel that they realize where the need for accuracy was greatest and where it did not count as much and, therefore, might slight the work to some extent.

An Educated Stooge Is Not a Rival

By JOHN TOOKER

TRAINING and educating power plant employes is an important subject and I am very glad to see it brought up. Also I would like to add my own opinion on this subject for I believe that the power plant chiefs who make some effort to train and educate those who serve under them will have, as a result, better operated plants and a loyal operating force.

Every power plant, and especially the larger ones, should be something more than power, or power generating stations; they should be educational institutions as well where every young man who enters one of them as an employe may expect sympathetic help and encouragement from those in charge while learning all the practical operating and maintenance details.

It is not necessary to start schools or classes for this purpose for much can be accomplished in a simpler way. First of all each foreman or watch engineer must take a deep personal interest in the men who serve under him. He must encourage them to ask questions for in answering, or attempting to answer, them he will find that he is adding to his own knowledge at the same time.

Some of them will bring up the argument that a watch engineer in a large power plant will be too busy to do this but the seeming paradox is, that the more of it he does the less busy he will be for he will soon have a force requiring less and less supervision as they increase in knowledge and efficiency.

The argument that if you train the man serving under you he will soon be looking for your job is the last refuge of an ignorant man. It is perfectly true that such a man will desire your job and the man who does not have that ambition does not belong in a power house, but if you train and educate him you will gain his respect and good-will so that he will want to reach a higher position only by the most honorable means.

In the plant where I was privileged to serve, some of the foremen and watch engineers tried out the theories that I have here outlined and were more than gratified at the results First of all, each man was trained to fill the next higher position so as to be sure of reserve help in emergencies. Men were encouraged to ask questions and to discuss the operating and maintenance advantages or disadvantages of newly installed apparatus. In some cases where a man had been incorrectly or not fully informed on some question the one who gave the information would look up the facts and return to the employe with the correct information.

Some watch engineers trained their subordinates for license examinations, putting them through written examinations, and by this course earned the gratitude of their men when they were able to pass the licensing board with flying colors. It was not long before such a course began to show results and we had a loyal and efficient force of employes who respected their officers and were ready and willling to serve in any capacity. We had several potential engineers among the oilers and every vacancy had a trained man ready to step into it.

Every man who holds a responsible position in a power plant knows that power plant operating is a trade or profession (whichever title you choose to give it) that requires a great deal of knowledge and skill. Constant and rapid changes in apparatus and operating methods requires him to keep fully informed of what is going on in his world. He also knows that he is here for only a few short years and it is his duty to pass on his knowldge and experience to others so that those who follow him may carry on to still greater achievements.

The point I wish to emphasize is, that the man who trains and educates those who serve under him will gain increasing satisfaction from such a course. His own dignity will be enhanced by the respect and gratitude shown him by the men he has helped, and he will be proud of the progress they have made under his training.

MECHANICAL POWER

Fats and Oils Affect Belt Materials

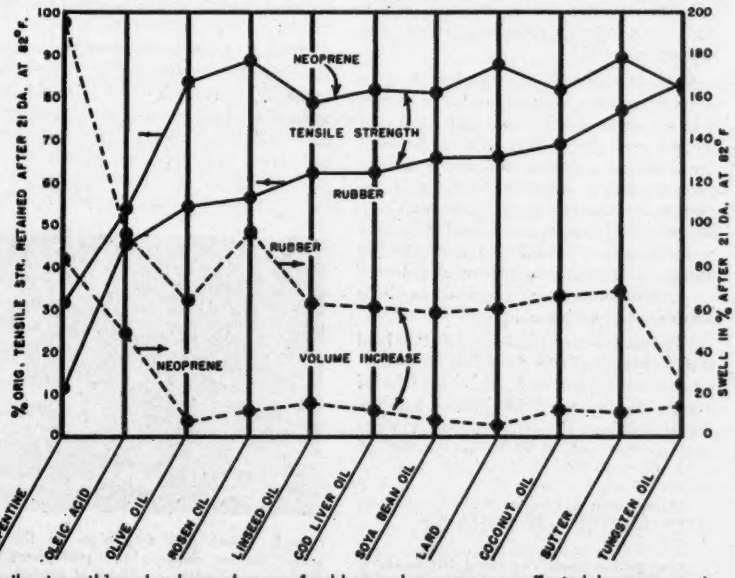
Accelerated laboratory tests with various fats and oils indicate the effect of length of exposure and temperature on rubber and neoprene materials for hard service

DUE TO rapid deteriorating effects of oil and rubber, it cannot be used in many applications where its resilient properties are advantageous. The resistance of neoprene compounds to petroleum products was recognized early. Success in this field led to experiments with vegetable oils and fats.

While these miscellaneous tests indicated uniformly better service, they did not give data in a form that could be translated into service conditions. To remedy this, the Du Pont Company conducted a series of accelerated laboratory tests on representative animal and vegetable oils. Test data in the accompanying chart were made with neoprene and oil resisting rubber samples completely immersed for 21 da. at 82 deg. F.

In the non-drying vegetable oils, soya bean, tung and linseed, the resistance to deterioration is almost directly proportional to the iodine number, being most severe with oils of a high iodine number. With the exception of rosin oil and turpentine the change in volume or swell is small.

At higher temperatures, the resistance of both rubber and neoprene decreases. Results of immersion tests for 21 da. at 212 deg. F. as compared with immersion at 82 deg. F. for a different series of tests are shown by the accompanying table. In these the tensile strength of the orig-



Tensile strength[1] and volume change of rubber and neoprene as effected by exposure to 11 different oils. The oils tested fall into several well defined groups but are arranged above in the order in which they affect rubber

[1]In correspondence with the Editor, Allen F. Clark, of the Rubber Chemicals D.v., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., draws attention to the fact that tests of rubber goods do not compare in accuracy with tests of such materials as steel, for instance, although the laboratory men consider the stress-strain tests accurate within 5 per cent. In testing rubber for tensile strength a dumbbell sample approximately ⅛ in. thick is used. The test piece is held in the jaws of the test machine by a friction clutch. When the sample is saturated with oil the tendency to slip is great even when an abrasive is used in the jaws to give a firmer hold.

Comparative effect of temperature on tensile strength and volume after immersion for 21 da.

Material	21 da. at 82 deg. F. % Tens. Str. Retained	21 da. at 82 deg. F. % Volume Increase	21 da. at 212 deg. F. % Tens. Str. Retained	21 da. at 212 deg. F. % Volume Increase
SOYA BEAN OIL				
Rubber	63.7	59.6	52.7	60.6
Neoprene	98.0	9.1	48.5	58.9
COD LIVER OIL				
Rubber	69.2	61.7	56.0	61.4
Neoprene	87.9	11.4	62.6	53.6
COCOANUT OIL				
Rubber	75.9	66.5	1.7	262.0
Neoprene	92.9	11.2	36.4	79.4
LARD				
Rubber	73.6	59.6	6.7	152.0
Neoprene	99.0	4.7	64.6	47.3

inal samples was 2275 and 2475 lb. per sq. in. respectively for rubber and neoprene.

The effect of temperature on volume change is particularly evident. In this connection the action of oleic acid on neoprene is unusual. At 82 deg. F. the deterioration and volume change is normal. At 212 deg. F. immersion, however, the swell is very rapid at first but at from 2 to 5 da. the swell decreases until at the end of 21 da. the volume is about half that of a comparable sample immersed the same length of time at 82 deg. F. It is not yet known whether this applies to all fatty acids or materials high in fatty acid content.

In view of this peculiarity of oleic acid, it is recommended that applications of neoprene, coming in contact with fatty acids at the higher temperatures be preceded by laboratory tests. With this exception neoprene is recommended when resistance to animal and vegetable fats is required, due to the small swell, resistance to tear, retention of tensile strength and ageing properties.

Belt Slip

By W. F. SCHAPHORST

THIS MATTER of belt slip is much more important than many executives realize. For example, this writer has before him a report concerning a large company which is actually saving $1656 pear year per drive after making an apparently simple change from one type of belt drive to another type of belt drive. The new drive, according to the report, saves 23 cents an hour, and since the belt runs 24 hr. a day, 300 days a year, the annual saving per drive is $1656.

Also, here is another report concerning four belts in a large plant. The four belts save $52 a day. According to the company's records a former type of belt would last only three days. Now they are using a belt which lasts five times as long at a saving of $783 for the four belts.

To be sure the rapid wearing out of a belt is not always attributable entirely to belt slip, but, on the whole, slip is usually the thing that is primarily responsible for the ultimate wearing out of belts, whether rapid or slow.

A large leather belt had been giving trouble due to charring and consequent premature wearing out despite the fact that it was equipped with a wrapper pulley. After a careful examination I wrote a report which contained the following comments and recommendations:

1. The large pulley won't slip because large ones never do, and the wrapper pulley shouldn't slip, therefore the small pulley on the motor is the one that does all the slipping and causes the damage.

2. The face of the wood pulley is somewhat grooved. Contact, therefore, is not uniform and is probably one of the causes of slip. Pulley faces are at their best when kept smooth.

3. The arc of belt contact on the small pulley can be increased by moving the motor closer to the compressor. This will permit the wrapper pulley to drop and increase the wrap. The wrapper pulley should also be closer to the small pulley.

4. Burned and worn spots are all in the center of the belt because that is where the pressure is greatest due to the crown of the pulley. Hence with the slipping of the small pulley the greatest temperature occurs at the center of the pulley causing the belt to burn along its center line.

My recommendations are that a new belt be installed and with it a new pulley of correct diameter be placed on the motor. Then increase the arc of contact of the belt on the small pulley by following paragraph 4, above.

We Reset a Boiler

By B. H. WHITEHOUSE*

SEVERAL unsatisfactory conditions including emission of black smoke, abnormal steam pressure fluctuations, hand control by unskilled help subject to rapid turnover, as well as a desire to reduce operating and maintenance costs made changes in our boiler plant desirable. The major equipment consisted of three 410-hp. Oil City inclined water tube boilers, fired with Westinghouse Rooney (inclined-front feed) stokers in small dutch oven settings. After a discussion of furnace design and boiler operation, with the authorities, they decided to replace one complete furnace, salvaging only the boiler and the baffles, which had been rebuilt previously with this change in view.[1]

The old setting was too low to give proper furnace volume and the boiler was suspended in the front and supported in the rear by rollers placed between the waterleg and masonry which was in poor condition. Operation was all hand except for the automatic feedwater regulator. The change was intended to give a furnace that would: be adaptable to automatic operation; reduce the smoke to a minimum; and, require as little maintenance as possible.

To relieve the masonry of the load the rear end of the boiler is now suspended as shown in Fig. 2. A piece of copper ⅛ in. by 2 in. placed between the U-bolt and the boiler drum prevents chaffing but this strip is not shown by the drawing. This leaves the boiler free to expand and contract without causing undue strain on the brick work.

For firing we selected a Firite (spreader type) stoker, which because only a shallow wind box is needed beneath the stationary grates, permitted an adequate furnace volume without excavation or without raising the boiler. Furthermore these grates work in very well with the wood waste which is occasionally available. This wood refuse, mostly shavings, enters as high as possible in the center of the front wall so that most of it burns in suspension with the coal dust, a desirable condition when the two fuels are burned together.

Forced draft is supplied by a Bailey fan directly connected to a constant speed Wing turbine so as to avoid operating difficulties in case of electric power difficulties or failure. Steam pressure and draft pressures are maintained automatically at any predetermined value by Cash controls and feedwater is han-

Fig. 1. Front and side view of the new boiler setting showing the steel work, the stokers, combustion control and forced draft fan. Note the wood waste chute coming in from the left

*Engineman-in-Charge, Milwaukee County House of Correction, Milwaukee, Wis.

[1]See Boiler Tests Pay Good Dividends by B. H. Whitehouse, p. 102, August, 1941. The explanation of the efficiency figure of 115 per cent mentioned later is also covered in the August, 1941 article.

dled by a Copes Flomatic regulator. In case of boiler failure or other serious trouble the fuel supply may be stopped and the fire on the grate will burn out in from 3 to 5 min.

Furnace walls are Ramtite plastic firebrick of the air cooled type, with 9 in. of plastic brick, 5 in. of air space and 8 in. of common brick on the outside. This type of wall extends up to the fourth row of boiler tubes. Above this the wall is solid, lined with No. 1 firebrick. The front wall is also air cooled up to the steel support above the fire door arches so as to prolong the life of this section. Above this the front wall is solid, 22 in. thick with 9 in. of plastic lining.

The bridgewall is solid; 9 in. of plastic lining in the firebox backed with 14 in. of No. 1 firebrick. The flyash ejectors shown in Fig. 3 pass through the bridgewall and discharge into the firebox. The rear half of the side walls are solid, lined with No. 1 firebrick as is the rear wall, except where the blow-off pipes are located. Here the brick in a section around the pipes are laid without breaking joints to permit easy removal for repair or inspection of the pipes and fittings without damage to the wall.

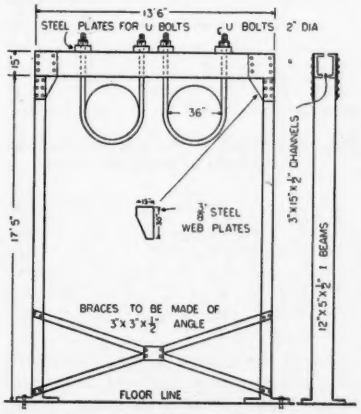


Fig. 2. Design of the steel work for supporting the boiler independent of the brick work

Inlets for the air-cooled side ports were built as shown in Fig. 1. The circulation of air is downward to the level of the grates, a necessity because the firing floor for this unit is level with the old ash-pit floor.

Asbestos rope was used longitudinally along the boiler drums (held in place by the corble of the walls) and all around the waterlegs for expansion purposes. To prevent cracking, Heattite was used in a perpendicular expansion joint at: the rear end of the side air-cooled sections extending up to eight courses from the top of the setting; at both ends of the bridgewall; and, between the bridgewall and the baffle.

With this setting it is possible to remove and replace any section of the outside wall without damage to any other section or the lining. In the firebox lining, sections 3 ft. square can be removed and replaced without damage to any other section. Provision is made

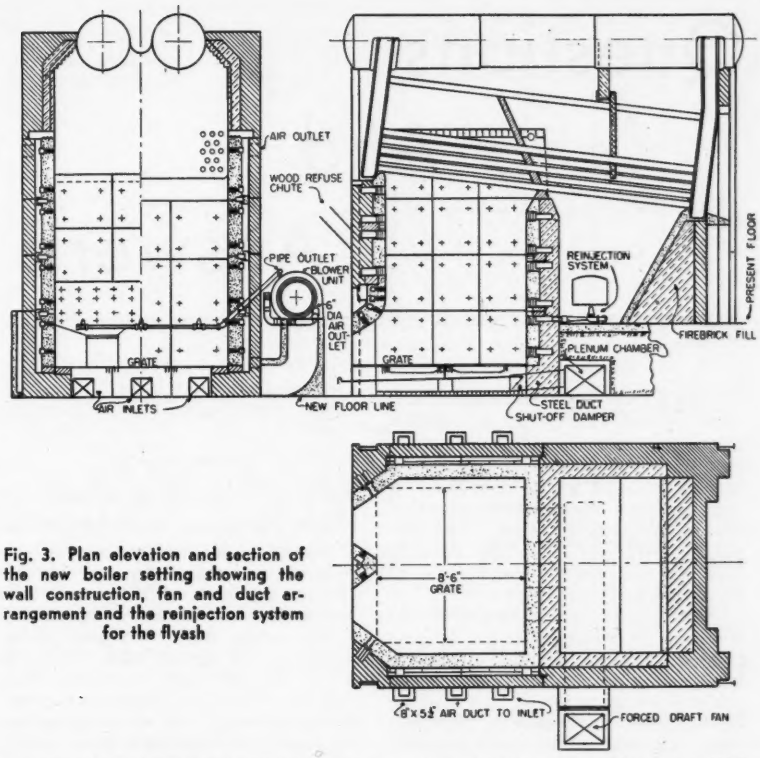


Fig. 3. Plan elevation and section of the new boiler setting showing the wall construction, fan and duct arrangement and the reinjection system for the flyash

for expansion around each section. The furnace lining other than plastic can be handled in the same way only in larger sections.

It may be well to mention that when burning wood with coal, the air supply should be increased sufficiently to burn the wood that will continue to enter the furnace after the regulator cuts down the air and coal supply. If this allowance is not made the CO_2 and furnace temperature will increase during these periods, and if prolonged, will cause clinker and slag formation and possibly black smoke as well. This excess air adjustment means, of course, a slightly lower CO_2 when operating without the wood refuse. It is also essential that the arrangement for feeding wood refuse should make "slugging" the furnace impossible, with the feeding at a uniform rate so that the air supply can be adjusted properly.

After 2 yr. service, operating about 10.5 mo. annually, no refractory repairs have yet been necessary, stoker part and grate replacement for all three furnaces has decreased from approximately $3300 a year to $300 and most of this was spent on the old units. Oil requirements for the old units (when in operation) are 15 gal. of steam cylinder oil and 30 gal. of stoker oil per month. The new unit requires 50 lb. Keystone No. 44 grease, 5 gal. ice machine oil, and 1.5 gal. steam turbine oil annually.

Fuel consumption decreased from 5337 t. for 84,000,000 lb. steam in 1938, to 5003 t. for 100,000,000 lb. steam in 1940. The same grade and analysis of coal was used both years.

Boiler tests run on this boiler with the old settings showed an efficiency of 78.09 per cent and, with coal at $3.99 per t., a fuel cost of 19.71 ct. per 1000 lb. of steam. Tests both with and without the wood show a very little difference. With the new setting the efficiency increased to 88.7 per cent when burning coal alone and 115 per cent[1] when burning wood with the coal. Fuel cost per 1000 lb. of steam with the coal alone was 16.45 ct. per 1000 lb. of steam and with wood and coal together the cost was cut to 12.68 ct. To give comparable results coal costs were figured at $3.99 per t. with no charge made for the wood waste.

It is difficult to ascertain from the appearance of the stack whether or not the plant is in operation, except when dusting tubes or cleaning fires. When in operation this unit is entirely automatic and only requires attention for lubrication, filling of the hoppers, cleaning the fires, etc. This greatly increases the reliability of the entire plant, a factor of some importance where all work is done by unskilled, inexperienced inmate help, with a licensed engineer on each watch in a supervisory capacity.

To date there is only one very small but visible crack developed. It is near the top, extends from the top of the expansion joint in one side of the setting up at a 45 deg. angle and towards the rear of the furnace.

The support for the rear end of this boiler was installed at a cost of $250; the furnace was erected by The Ramtite Co. at a cost of $2400; and the stoker and accessories were installed by The Hoffman Combustion Eng. Co. at a cost of $5200; making a total of $7850. Savings by the equipment have more than offset this expenditure in 2 yr. of operation at the 1940 coal price of $4.77 per t.

Questions And Answers

Question No. 183

Drying Air by Refrigeration

We would welcome any information that readers can give with respect to the installation and operation of a refrigerating system after an air compressor in order to lower the moisture content of the air. We have been using caustic potash to purify, and remove the moisture from air used for the manufacture of the oxygen in a liquefying tower.

Since caustic potash cannot be obtained at the present time due to government priorities we are considering lowering the temperature of this air to condense the moisture and thus save the caustic potash for removing impurities only. Any information from engineers knowing about or using such an arrangement would be useful and very much appreciated. A. A. E.

Question No. 184

Substitute Materials

While we have a number of new problems coming up, two are giving us particular concern. The first is in connection with the replacement of a large number of bronze sleeve bearings. The other is in connection with chromium plated pump rods we have been using because of their long service and corrosion resistant properties. Have any readers suggestions as to substitute materials or the re-use of the old parts? R. K.

Question No. 185

His Exciters Hunt

Down in the engine room we have a tough nut to crack. To carry our electrical load we use three engine-generator units: 1850, 526 and 150 kv-a. When we parallel the large unit with one of the smaller ones, one of the two exciters starts to hunt sooner or later. Sometimes it's one, sometimes the other. The only way we can stop it is to cut out one of the machines. Can you help us with this make-the-exciters-stop-hunting problem? W. R.

Question No. 186

He Wants Air Filters To Last Longer

We have 32 spun glass air filters which have to be discarded after being vacuumed three or four times. At $1 each the replacement cost runs about $130 a year for material and not counting the labor. Is it practical to arrange some kind of a prefilter ahead of these units to catch some of the dirt and relieve the glass units of some of the load so as to increase their useful life and reduce the cleaning and replacement costs? W. M.

Question No. 187

Slag and Spalling Mean High Furnace Maintenance

Costly furnace maintenance has been bothering us for some time due to high constant overloads (200 per cent) and low fusion ash coal which gives us a bed of hot syrupy stuff that causes undue spalling of our furnace walls. Replacing spalled brick in a wall 19 ft. long, 19 ft. high and 12 ft. wide is quite an expense, to say nothing of the enforced outage. We would like to install water cooled walls, but can't take the time out even though we could get the tubes and headers. Any tips on operation, air cooling or different type of brick which would help us would be appreciated. H. G. K.

Question No. 188

Steel Tubes for Heater Replacements

Cuprous nickel, arsenical copper and even brass tubes which we keep on hand for use as replacements in our closed feedwater heaters and condensers, are practically gone and we understand are no longer available except for very special applications. It seems that we may be forced to use regular steel tubing and are a bit skeptical as to how it will withstand the severe corrosion met with in this service. Have any readers had experience with this? Are any special precautions necessary when rolling in the tube ends or are there any special requirements for packed tubes? Can the steel tubes be used as replacements in with the copper alloy tubes or should the entire tube bundle be replaced with steel at the same time? E. Z.

Answer No. 125

How to Figure Tonnage Of a Brine Cooler

On p. 96 of the December, 1941 issue A. Daniels asked how to figure the tonnage of a brine cooler with a flow of 1200 g.p.m.; a temperature in of 15 deg. F.; and a temperature out of 9 deg. F.

The specific heat of brine varies with the concentration and the kind, that is, sodium chloride or calcium chloride. For a rule of thumb I use 7 B.t.u. per gal. regardless of the concentration, pure water having about 8.33 B.t.u. Since 288,000 heat units absorbed or given up within 24 hr. equals a ton of refrigeration, and since 1200 gal. of brine per min. are cooled from 15 to 9 deg. F., the cooler tonnage is:

$$\frac{1200 \times 7 \times (15-9) \times 60 \times 24}{288{,}000} = 252 \text{ t.}$$

George Holman.

Answer No. 142

How Can Short Circuits In Underground Cables Be Located?

On p. 96 of the December issue D. M. Mustard requested information on practical methods of locating faults, in lead covered lighting cable buried 12 to 16 in. underground, without completely digging up the street between lighting standards. He thought that it might be possible to do this by means of a head set and coil carried above ground as a detector. The following reply touches on this point and then goes on to cover in considerable detail more conventional methods.

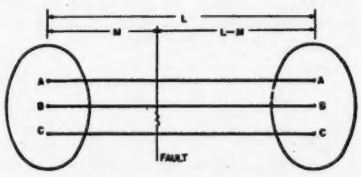


Diagram outlining the general procedure for locating faults by resistance values

The cable system as described does not lend itself to the application of any kind of a tone or sound test due to the shielding effect of the steel tape. Where a substantial or solid ground exists it is a different matter and is not covered by this question.

Since the system is used for multiple lighting there may be points of sectionalizing or at least places where portions may be sectionalized. This will enable the fault to be localized within certain limits. The application of the operating voltage using a test lamp in circuit will confirm the existence of the short circuit in the particular section, between the two conductors involved.

If it is not possible to localize as described the main run must be cut; usually this can be done at the lamp base until the faulty section is located and isolated from the good sections of the cable. Just how many cuts must be made for the last named test is essentially a matter of judgment or plain good fortune.

Sometimes if the short circuit is only a partial one there may be an indication in the way the lights are burning beyond the point where it exists. Again the place may be indicated by heating or smoke if it is located at the base of a lamp where it is exposed or in a pull box or splice box.

When a short circuit has been located under the ground between 2 points the actual fault can be closely

located, say within 5 to 10 ft., by means of resistance tests made from both ends of the isolated section.

The appended diagram indicates the general procedure. Having isolated the location of the fault between two points marked 1 and 2 in conductors B and C, the resistance of the loop formed by the 2 conductors should be measured from 1 to 2.

This can be done by means of a bridge or by sending a current through the fault and measuring the voltage at the point of supply with a suitable low reading voltmeter. The current will have to be limited by a resistance in the source of supply so the voltage drop will be low.

From the ratio of volts to amperes the resistance of the loop can be obtained, and, knowing the resistance per foot of conductor, the distance from the station will equal one-half the resistance of the loop divided by the conductor resistance per foot.

Measured separately from stations 1 and 2 the fault location may be checked. Care must be taken to make such a test rapidly to avoid heating the conductors and causing the resistance to change materially. If the stations are not far apart and a third conductor without fault is available, another test can be made on the good conductor and the fault location estimated by using the relative ratios of the resistances obtained on the faulted conductors to the unfaulted conductor.

This result will indicate where to dig and if the estimated location is exposed with a trench say 5 to 10 ft. on each side of it, the application of a high current may indicate the point by local heating. If it does not, the cable must be cut and the tape stripped each side of the fault. The writer has located faults within 3 ft. of their actual position as a routine procedure.

Where the conductors are only partially short circuited and the heating from the test current causes the resistance to vary, it may require time and patience, perhaps even more than one cut to locate the fault.

A resistance test of the good conductor, with a return conductor on top of the ground as a return, can also be used.

C. O. VON DANNENBERG.
Brooklyn, N. Y.

Answer No. 144

What Is the Collapsing Pressure of a Condenser Tube?

IN THE DECEMBER, 1941 issue, p. 96, O.A.H. asks for a formula to calculate (1) the collapsing and (2) the rupturing pressure of seamless cold-drawn condenser tubes made of steel, specifically a No. 11 gage of undisclosed diameter. This is a subject upon which authorities disagree violently, and while I do not pose as an authority nor pretend to understand all of the finer points, I have for practical purposes selected the Jasper and Sullivan formula from the mess of formulas available primarily because the "yield" point is given weight.

If O.A.H. would read the discussion section at the end of Jasper and Sullivan's[1] article he would realize that the final decision has not been made about the collapsing pressure formulas. Professor Stewart, author of the classic[2] in this field, does not see "eye to eye" with Messrs. Jasper and Sullivan in the discussion.

Authors[1] state (page 230 of the original A.S.M.E. paper cited): "It is believed that on the basis of the following procedure the collapsing strength of any commercial steel tube can be determined from its dimensions, the yield point, and its degree of out of roundness." The equations with minor changes from the original are

$$P = \left(\frac{100 - A}{100}\right) \times S \times \frac{T}{R} \quad \text{....Eq. 1}$$

$$P = \left(\frac{100 - A}{100}\right) \times S \times \left(\frac{R^2 - r^2}{2R^2}\right) \quad \text{....Eq. 2}$$

Where

P = Collapsing pressure, lb. per sq. in.

A = Per cent reduction of maximum stress (S) due to out of roundness. For a perfect tube A = zero and term (100—A)/100 becomes unity.

S = Maximum compressive stress in metal of tube at collapsing pressure in lb. per sq. in. for a perfect tube.

D = Outside diameter of tube, inches.

d = Inside diameter of tube, inches.

R = Outside Radius of tube, inches.

r = Inside Radius of tube, inches.

T = Thickness of tube wall, inches.

Use Eq. 1 when D/T is greater than 32 and use Eq. 2 when D/T is less than 32.

Values of S for a perfect tube can be lifted from (Table 6, from p. 223 of the original paper), the curves in Fig. 1 which show the relation between Maximum Compressive Stress or S at collapsing pressure and the Ratio D/T for homogeneous steel pipe with uniform roundness and wall thickness, for, various values of yield point when the length between supports is GREATER than EIGHT tube diameters.

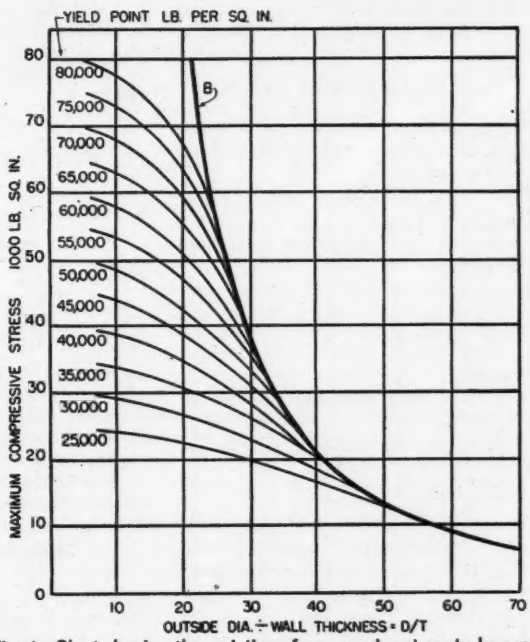


Fig. 1. Chart showing the variation of compressive stress to be used in Eqs. 1 and 2

Yield point is defined at "That unit stress at which deformation increases without any increase in the applied load or increase in the internal stress." It is always higher than the elastic limit. The continuous Curve B, Fig. 1, shows values of S calculated from Strums theoretical equation. The family of curves to the left of B shows values of S obtained from test for various values of yield point.

If we know or could estimate values for all the factors, solving for P would be merely a simple matter of substitution. The uncertain factors are Yield Point and Out of Roundness. Handbooks and catalogs can be resorted to for yield point values. Approximate values for Shelby-National seamless steel tubes are as follows:

	Yield Point	Ultimate T. S.
Soft and Ductile	35,000	50,000
Medium T.S. and Ductility	48,000	65,000
General Use	55,000	75,000

Selection of a value of A for commercial tubes is a matter of making a good guess since it depends on the out-of-roundness percentage, the ratio D/T, and the yield point. For values of D/T less than 20 and Y.P. from 30,000 to 40,000, giving A a value of 10 per cent would be safe. (Anyone interested in accurate work could consult Fig. 22 on page 229 and example cited on page 230 of the original paper.[1] It is not a simple process.)

Internal Pressure To Rupture Tubes

When the thickness of the tube wall is small compared with the diameter, the stress produced is practically uniform throughout its thickness.

[1]Collapsing Strength of Steel Tubes by Jasper and Sullivan. Trans. Amer. Soc. of Mech. Eng., Vol. 53, 1931, APM-53-17b, pp. 219-245. Can be found in many public libraries. A complete list of tests on tubes is given in the A.S.M.E. Sixty Year Index.

[2]Collapsing Pressure of Bessemer Steel Lap-welded Tubes, 3 to 10 in. Diameter by R. T. Stewart. A.S.M.E. Transactions, Vol. 27, 1906, p. 730.

Rupturing Effect = Resistance of Metal

$$P \times d = 2 \times T \times \text{Stress} \quad \ldots\text{Eq. 3}$$

When the thickness of metal is considerable in relation to diameter (as in case of small tubes) the stress produced throughout the thickness of metal is not uniform and Eq. 3 becomes

$$P' = S' \times \text{Log}_e\ (\text{O. Diam./I. Diam.}) \quad \ldots\text{Eq. 4}$$

For steel tubes Eq. 4 must be modified and becomes

$$P = (S/2)\left[(R-1) + 2.303 \times \text{Log}_{10} R\right] \quad \ldots\text{Eq. 5}$$

Where

P = Internal rupturing pressure, lb. per sq. in.

S = Ultimate tensile stress, lb. per sq. in.

R = Ratio of

$$\frac{\text{Outside Diam.}}{\text{Inside Diam.}} = \frac{\text{Outside Radius}}{\text{Inside Radius}}$$

2.303 = Conversion Factor to Convert from Log to the Base 10 to Hyperbolic Logs (base e). Use of this factor avoids the necessity of using hyperbolic log tables which are not as common as tables of common logs.

The foregoing formulas were taken from p. 33 of "Some Considerations Regarding Cast Iron and Steel Pipe" (A British Treatise) by John Sharp, Longmans Green—1914. Daugherty "Hydraulics" (McGraw-Hill, 1925) on p. 32 also cites this formula and states "Equations with S understood as Compressive stress" would also hold for external pressure provided that the pipe remained truly cylindrical.

A review of the matter published regarding the collapsing pressure of tubes shows that different authorities have decided and different views regarding the merits of the many formulas proposed and some formulas do give divergent results.

San Francisco, Cal. CHARLES HUBBARD

Try Looking Up the Code

O.A.H. requests information regarding the collapsing pressure of a No. 11 gage seamless soft steel condenser tube, but he however neglects to give the diameter of the tube. The strength of a tube or a vessel subject to external pressure does not depend merely upon the elastic limit or ultimate strength of the material used, but is largely governed by the tube's degree of out-of-roundness, and the distance between the tube supports with relation to the tube diameter.

Out-of-roundness is influenced by the distance between supports due to the deflection causing the tube to assume an elliptical cross-section, and the greater the departure of the tube from a true circle the less ability it will have to withstand external pressure. Likewise, imperfections in manufacture, and carelessness in handling causing dents or flat spots, may contribute to a collapse at a pressure much less than that calculated and based upon the tube diameter and wall thickness.

Collapsing pressure of steel tubes may be calculated from the following formulae (a suitable factor of safety should be used for obtaining the working pressure):

$$P = 1000\left[1 - \sqrt{1 - 1600\ (T^2/D^2)}\right] \quad \ldots\text{Eq. 1}$$

Where

P = collapsing pressure in lb. per sq. in.

T = thickness of tube in inches.

D = outside diameter of tube in inches.

Equation 1 can be used for tubes where P is less than 581 lbs. or T/D is less than .023. Where these values are exceeded the following formula may be used:

$P = 86{,}670\ (T/D) - 1386$ ....Eq. 2

for cold drawn seamless steel tubes with T/D less than .025 use Eq. 3 where

$P = 50{,}200{,}000\ (T/D)^3$ ....Eq. 3

While Eqs. 1 and 2 were developed by experiment on steel tubes (lap-welded) they may be applied to either grade of tube. I would suggest that in selecting the proper gage tube to withstand collapsing pressure that the tables for tubes for such use in the Boiler or Unfired Pressure Vessel codes be consulted. The sizes given have ample provision for corrosion, etc. The Unfired Pressure Vessel Code also gives charts for determining the allowable pressure on vessels subject to external pressure.

The last part of the question is not quite clear to me as I can't make out whether reference is made to internal pressure causing bursting, or external pressure causing collapse. For internal presure to cause bursting the old formula

$$P = (T.S. \times t)\ R$$

where T.S. = tensile strength

t = thickness in inches

is used. The inside radius of the outside course being used unless the thickness exceeds 1/10 the radius, when the outer radius should be used.

For external pressure to cause collapse a formula is given in Kent's Vol. 3, Chap. 7, which is impractical for everyday usage as it takes into consideration the modulus of elasticity, allowable working unit deformation, etc.

The most practical way of determining the allowable collapsing pressure on a vessel would be by referring to Paragraphs U-120 to U-138 inclusive of the A.S.M.E. Unfired Pressure Vessel Code* which include charts for the determination of the allowable pressure based on the relation of diameter to thickness, length to diameter, etc.; and also give the degree of permissible out-of-roundness.

Melrose, Mass. E. MAC DERMOD

*Can be purchased from the American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y. for $0.75 per copy. This is Section VIII of the Boiler Construction Code which sells complete for $5.50.

Tubes and Tanks Do Collapse

WHILE traveling through Minnesota recently I saw, through the car window, an unusual sight, a collapsed vertical tank. The tank was 60 or 70 ft. high and 15 to 20 ft. in diameter. Undoubtedly it had been caused by a vacuum, i.e. by external pressure. It bore evidence of having been restored to nearly full capacity by the creation of internal pressure, which is the simplest and best way to restore collapsed tanks and pipes, wherever possible.

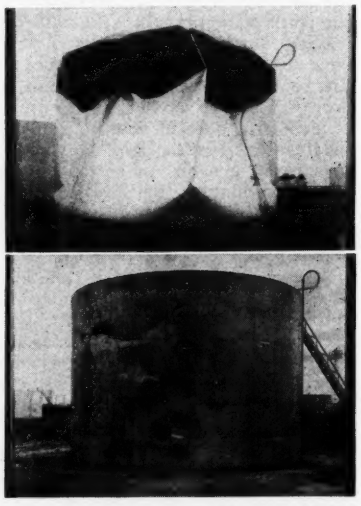


Fig. 2. Before and after views of a collapsed oil tank as snapped by H. P. Rigsby of the Dept. of Mechanical Engineering, A. & M. College of Texas. Top view shows tank collapsed when a vacuum was pumped on it because the air vents did not work. The bottom view shows the tank as forced back by pumping in water under pressure. The tank was completely arc welded and not a joint failed. Incidentally the tank cost $35,475 ($2,475 for labor) an estimated saving of $24,525 over riveted construction

A number of years ago the large pipe line supplying Los Angeles with water flattened out for many miles due to the formation of a vacuum caused by the suction of the water itself. When water under pressure was re-admitted into the pipe line it resumed its normal size and shape and appeared to be none the worse for the experience.

(Editor's Note: At this point Mr. Schraphorst introduces an equation similar to Mr. Mac Dermod's Eq. 1, except with a constant of 500 instead of 1000. He continues:)

Test Results on the Collapsing Pressure of Thin Walled Pipe

Diam. in.	Thickness in.	Noticeable distortion, lb./sq. in.	Collapse at, lb./sq. in.
12	0.0312	1.0	3.0
12	0.0375	1.0	3.5
12	0.05	2.5	7.5
15	0.0375	1.5	3.0
15	0.05	2.5	4.5
15	0.062	3.0	7.5
15	0.078	6.0	Uncollapsed at 10.0*

*This pipe remained uncollapsed at the pressure of 10 lb.

The rule is a modification of one of Stewart's well known formulas which was developed for greater thicknesses and heavier metals such as used in boilers, flanged or screw piping, and in large vacuum apparatus. The rule given above, for thin metals and large diameters, was arrived at by comparing one of the Stewart formulas with the following test results shown by the table.

Answer No. 148

How Can He Prevent Carryover?

CLYDE WITTENMEYER operates a 100-hp. boiler which primes when the safety valve pops. On p. 96 of the December, 1941 issue he asked what could be done to stop this, specifically if a dry pipe would help.

First one should try to find the cause of the carryover. There are many reasons for this, but in this case the cause is either overload or carrying the water level too high. To make sure, however, I would make my inspection a process of elimination, a good way to overcome a lot of engineering headaches. My first procedure would be to lower the water level to about half a glass. Lowering of the water level increases the steam space of the boiler and it also gives off a dryer steam.

If this isn't the cause then I would check over the main steam line for trap trouble, if there isn't a trap between the main steam stop and the throttle valve then I would have one installed, making sure it is of the proper size to take care of the condensate so as to relieve the load on the steam separator.

As for C. W. installing a baffle under the dry pipe, it shouldn't be necessary if he can keep down the severe case of ebullition or violent agitation, and this may have to be done by making sure that the boiler is not forced beyond its capacity.

Philadelphia, Pa. WILLIAM T. MULLEN

Answer No. 151

Engineer Needs Help On Record Forms

IN THE January issue, p. 99, H.C.K. asked for information in regard to power plant record forms which could either be made or purchased.

Attached are two forms, one a daily log sheet and the other a monthly financial statement. Each sheet has been in use in our plant a good many years and with slight modification of titles can be used for a plant of practically any kind and size.

While the basis of our cost is on tons of finished product, it can just as well be adapted as a cost per room for a hotel or cost per bed for a hospital or cost per hog for a packing house.

You will note that the daily log sheet is merely divided between day and night operation. We have, however, some branches where we use three shifts and in such cases, the forms are modified to suit three sets of meter readings daily.

Deere & Co.
Moline, Ill. E. WINHOLT

Answer No. 162

What Determines Lead?

IN REGARD to L.B.'s question, lead is given an engine valve to increase the economy of the engine by establishing full header pressure on the piston head at the instant of reversal (giving a larger work area on the card), and is also used as a means of bringing the reciprocating parts to an easy, cushioned stop by opposing the final few inches of travel by the full header pressure.

Therefore, it is obvious that the amount of lead is determined from the header pressure, and the mass and velocity of the reciprocating parts of the engine. As a starting point, 1/32 in. per ft. of piston travel can be tried.

In vertical engines, slightly less lead is given the head end valve because the upward movement of the reciprocating parts is also opposed by the force of gravity. When striving for a quiet, economical engine, correct lead is of great importance. SAM WILLIAMS

Considers Vertical Engines Too

QUESTION No. 162, on p. 96 of the April, 1942 issue requests information on "What determines the amount of lead for steam engines?" Perhaps I can be of some help. The amount of lead varies from 0 to about ¼ in. It can be determined only by trial and the use of an indicator. Generally, only enough should be given to fill the clearance space and make a smooth running job when passing centers. A safe estimate would be 1/32 in. per ft. of stroke. The proper amount takes into consideration: Size and speed of engine, give more lead to

POWER PLANT REPORT

DEERE & COMPANY — Month January
John Deere Tractor Company Plant — Weeks 5
For Period December 28th to January 31st — Year 1942

A/C No.	POWER PLANT ONLY	ENGINE ROOM Labor	ENGINE ROOM Matl.	ENGINE ROOM Total	BOILER ROOM Labor	BOILER ROOM Matl.	BOILER ROOM Total	Power House Total
85	Bldgs. Grounds	10.30	3.87	14.17	10.30	3.88	14.18	28.35
86	Maintenance	216.43	822.65	1,039.08	785.36	212.31	997.67	2,036.75
85	Miscellaneous					169.70	169.70	169.70
86	Engr.-Firemen	1,296.58		1,296.58	1,414.54		1,414.54	2,711.12
87	Fuel				145.82	22,559.29	22,705.11	22,705.11
88	Lubs.-Waste	37.44	349.03	386.47				386.47
92	Insurance		25.00	25.00		25.00	25.00	50.00
94	Depreciation		729.70	729.70		1,399.80	1,399.80	2,129.50
	TOTAL	$1,560.75	$1,930.25	$ 3,491.00	$2,356.02	$24,369.98	$26,726.00	$ 30,217.00

Feed Water	91,818	M#	Output Sold	$	None
Steam Produced	90,614	M#	Total Power House Net		$30,217.00
Bir. Rm. Total Cost per M# Steam, $0.2949					

			Coal Equivalent	
Coal Used		Tons = Same	5 944	Tons
Oil Used		Gals. ÷ 150 =		Tons
Lumber (B.F.)		Bd. Ft. ÷ 1000 =		Tons
Total Fuel Used	→	→	5 944	Tons
Total Steam Produced	→	→	90 614	M#
Apparent Evaporation per Pound of Fuel	→	→	7.62	#

PRODUCED			OUTPUT SOLD			
Electric Power	1 904 300	KW	Steam	M#	$	None
Compr. Air (Steam)	124 438	MCF	Air	M Ft.	$	-
Compr. Air (Electric)		MCF	Power	KW	$	-
Compr. Air Total	124 438	MCF	Fixed Charges		$	-
Heating Syst. Exh. Steam	35 990	M#	Total		$	-
Heating Syst. Live Stm.	32 583	M#	PURCH. POWER			
Motor Generator Set (K-1)	19 100	KW	Max. Demand	1 636.32 KW	$	1,886.32
" " " (K-2)	28 100	KW	Direct Current	674 KW	$	34.46
			Elect. Power	263 300 KW	$	2,332.83
			Power House Net			$30,217.00
Total Power Consumed	2 215 474	KW	Total			$34,470.61

Tons of Fin. Prod	7 422.33	Tons	Cost per Ton	$	4.52
Compr. Air per Ton	16.33	MCF	KW per Ton		290.66
Steam per equivalent KW = (Steam Produced) ÷ (KW Produced + 7 x MCF Air (Steam))	= 42.08	#			

Power Plant Log — Date ____ Year ____

STEAM	Hours Run	METER READING 7:00 A. M.	METER READING 6:00 P. M.	Multiplier	QUANTITIES Day	QUANTITIES Night	TOTAL	UNITS
Boiler No. 1								M Lbs.
Boiler No. 2								M Lbs.
Boiler No. 3								M Lbs.
Total Steam								M Lbs.
Coal Burned								Tons
Evaporation								Lbs.
Boiler Feed								M Lbs.
H. P. Steam Out								M Lbs.
Compressor No. 1								M. C. F.
Compressor No. 2								M. C. F.
Compressor No. 3								M. C. F.
Total Air								M. C. F.
Shops Air								M. C. F.
Mill Room Air								M. C. F.
Foundry Air								M. C. F.
Total Air								M. C. F.
Power Co. Mtr.-D								K. W.
Power Co. K. V. A.								K. V. A.
Power Co. K. W.								K. W.
Generator No. 1								K. W.
Generator No. 2								K. W.
Total Power								K. W
City Water								Gals.
Well Water								Gals.
Hot Water								Gals.

REMARKS:

	COAL	ENG. OIL	STEAM CYL. OIL	AIR CYL. OIL
On Hand 7:00 A. M.	Tn.	Gal.	Gal.	Gal.
Received				
Total				
Consumed				
On Hand 7:00 P. M.				

Sample record forms showing a summary of power plant operation by day and by month. Note the effective way meters have been used throughout to simplify the cost accounting procedure

high speed engine; valve design, more lead to slow valves; noise level, proper lead gives a quiet job; economy, too much lead means negative work, too little lead, power loss and noisy operation.

Cincinnati, Ohio. WM. E. RIXMAN

Answer No. 169

Another Question About Power Factor

THIS question dealt with the calculation of the power factor at the generator which supplied 21 feeders the individual power factors of which varied from 60 to 100 per cent. The question asked by Earl Everline was answered on p. 98 of the April, 1942 issue. The two following answers elaborate on a simpler method of calculation.

A Graphical Solution and Two Shortcuts

AS PRINTED the answer to this question might be discouraging to a non-technical man. The method submitted below has been grasped by non-technical men in a few minutes' time. The solution of the problem took me 45 min. and required only a protractor and a scale graduated in tenths of an inch.

The first step is to draw the power factor vs. degrees curve by looking up the angle corresponding to the power factor from a cosine table. About five points will determine the curve shown as P.F. vs. Degrees curve of Fig. 1, and the angle for each power factor can then be picked off the curve. All currents of nearly the same power factor can be added to shorten the process.

The next step is to lay off the current for each power factor to scale, setting the zero of the protractor at the end of each current line for the next reading. When these are all drawn end to end, the length of the line (heavy dashed line of Fig. 1) from the last point to starting point gives the current, and the angle of this line with the base corresponds to the power factor.

In this problem, the line scales 1190 amp., and the angle is 30 deg., which, from the curve gives a power factor of .865 or 86.5 per cent.

If time were an object, a very close approximation may be obtained in 10 min. by averaging the power factors and adding the currents, thus:

1. Amp.		P.F. in %	2. Amp.		P.F. in %
290	at	90	85	at	84
140	at	91	80	at	68
150	at	88	72	at	72
580		89.5	237		77

3. Amp.		P.F. in %	4. Amp.		P.F. in %
150	above	83	580	at	89.5
150	below	83	237	at	77
100	near	100	817	at	83
400	at	90	400	at	90
			1217	at	87% Approx.

If there is an ammeter on the generator panel, another easy way to find the power factor is to multiply all the feeder currents by the power factor and add them. In the present problem, these add up to 1020.6. This, divided by the total current will give the power factor as $1020 \div 1190 = 0.86$ or 86 per cent P.F. approximately.

Pittsburgh, Pa. I. E. CHURCH

Suggests Using the Reactive Kv-a.

Referring to Question No. 169, we suggest another method, for calculating the power factor of the generator supplying the 21 feeders.

The method is this: (1) figure the in-phase amperes for each feeder by multiplying the listed amperes by the power factor; (2) figure the reactive amperes by means of the "reactive kv-a." shown by Table II. The total of the reactive amperes divided by the total of the in-phase amperes gives the factor 0.583 which, from the table, shows the power factor of the generator to be approximately 0.86.

Table I. The 21 feeder circuits as given in the original question together with additional data as calculated by Mr. Church

Feeder	Amp.	P.F. in %	Angle in deg.	Amp. P.F.
1	85	84	33	71.5
2	20	99	8	19.8
3	14	77	39.5	10.8
4	10	60	52.5	6.0
5	40	72	43.5	28.8
6	35	60	52.5	21.0
7	50	94	20	47.0
8	22	62	51	13.6
9	43	65	49.5	28.0
10	45	90	26	40.5
11	75	90	26	67.5
12	115	90	26	103.5
13	5	73	42.5	3.6
14	55	90	26	49.5
15	80	100	0	80.0
16	140	91	25	127.4
17	50	79	37.5	39.5
18	150	88	29	132.0
19	25	93	22	23.3
20	80	68	46.5	54.5
21	72	72	43.5	51.8
Total				1019.4

Table II. Ratio of reactive kv-a. to kw. for various power factors

Power Factor	Ratio Rkv a /Kw	Power Factor	Ratio Rkv a /Kw	Power Factor	Ratio Rkv a /Kw
1.00	000	.80	750	60	1 333
.99	.142	.79	776	59	1 369
.98	.203	78	.802	58	1 404
.97	.251	77	.829	57	1 441
.96	.292	76	855	56	1 480
.95	329	75	882	55	1 518
.94	.363	74	909	54	1 560
.93	395	73	936	53	1 600
.92	.426	72	964	52	1 642
.91	456	71	992	51	1 686
.90	484	70	1 020	50	1 732
89	.512	69	1 049	49	1 779
.88	.540	68	1 078	48	1 828
.87	.567	.67	1 108	47	1 878
.86	.593	.66	1 138	.46	1 930
.85	.620	.65	1.169	45	1.985
.84	.646	.64	1.200	.44	2.041
.83	.672	.63	1 233	.43	2.098
.82	.698	.62	1.265	.42	2.160
.81	.724	.61	1 300	.41	2.225

In this solution it is assumed that all the power factors listed are lagging, and that the individual feeder amperes can be totaled, that is, that the feeder amperes shown are the ultimate load amperes which total the load on the generator.

Table III. Individual feeder circuit calculators as made by Mr. Bordeau

Feeder	Amp.	P.F. in %	In-Phase Amp.	React. Amp.
1	85	84	71.5	46.2
2	20	99	19.8	2.8
3	14	77	10.8	9.0
4	10	60	6.0	8.0
5	40	72	28.8	27.7
6	35	60	21.0	28.0
7	50	94	47.0	17.1
8	22	62	13.6	17.2
9	43	65	28.0	32.7
10	45	90	40.5	19.6
11	75	90	67.5	32.6
12	115	90	103.4	50.0
13	5	73	3.6	3.3
14	55	90	49.5	24.0
15	80	100	80.0	0.0
16	140	91	127.4	58.0
17	50	79	39.5	30.6
18	150	88	132.0	71.5
19	25	93	23.2	9.2
20	80	68	54.5	56.0
21	72	72	51.8	50.0
Totals			1019.40	593.5

Then 593.5/1019.4 equals 0.583 and from Table II the P.F. is approximately 0.86.

The method described above is simply an addition of the vectorial components of each ampere load at its power factor, the summation of which gives the current triangle of the total load. This method is equally useful where the kv-a. and power factor, or kilowatts and power factor are known. It has the advantage of showing the lagging reactive amperes that must be compensated for by leading reactive amperes if the power factor is to be raised.

Electric Mach. Mfg. Co. S. P. BORDEAU
Minneapolis, Minn.

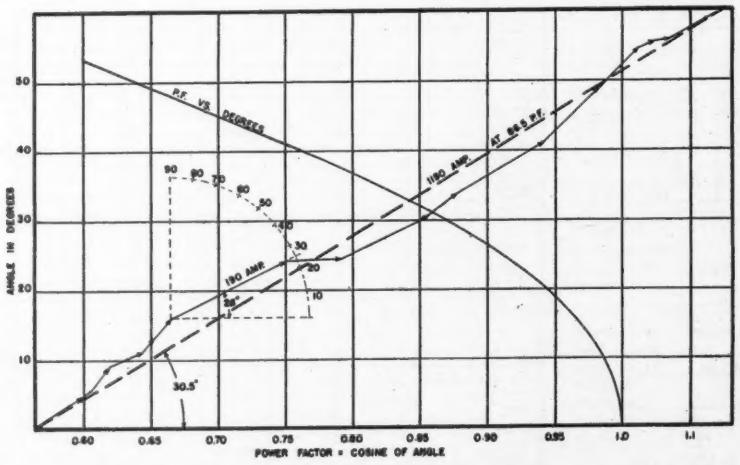
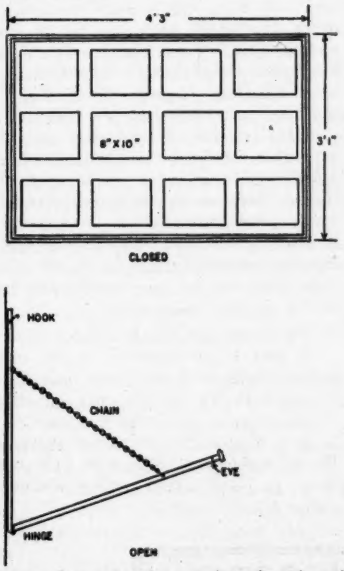


Fig. 1. Graphical solution as used by Mr. Church. P. F. vs. Degree curve was plotted from trigonometric tables. The other curve was obtained by plotting each of the 21 feeders to scale as explained in the text

Letters And Comments

License Frames

NOTICING the description of an engineers' license holder on p. 92 of the April issue, I thought that the one that is used in our plant might also be of interest. Licenses in our engine room were hung in various types of frames and in various locations for many years. In order to provide something more attractive and more uniform, a holder was designed, with the help of the foreman carpenter, that is shown in the accompanying sketch.



License frame details as explained, and used, by Mr. Kimball

The material was quartered oak and there is room for 12 licenses. It has never been entirely filled even with the boiler and air tank inspection certificates. As will be seen, the entire front part is on hinges and by unhooking it at the top, it can drop down and be held by the chains at each side. Then the licenses, still in their frames, are fastened to the inner side and the front part is closed up against the back panel which is fastened to the wall.

All of our licensed men, and the same is true of other engineers that I have ever noticed, provide a plain wooden frame made to take the license which is about 8¼ by 10¼ in. There was room enough on the front board of our holder so that these frames could be fastened on the inner side and just show the license from the outside. In this manner, it is possible for any man to remove his license together with the frame if he wishes to.

For many years holders of Massachusetts engineers' licenses have not been obliged to renew them annually. Recently a change has been made in the law so that these licenses must be renewed every year. The renewal is much smaller than the old form, but some of the engineers have simply opened their frames and laid the new form over the old and fastened them in that manner.

Cambridge, Mass. G. H. KIMBALL

Accurate Marking for Calibrated Gages

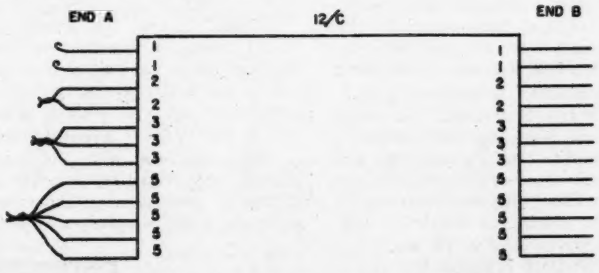
WHEN CONSTRUCTING home made apparatus to meet today's needs, it often becomes necessary to fashion a rod or bar, calibrated in gallons, inches, or some other unit. Marking off the rod in evenly spaced units by means of a yardstick, or a 6-ft. rule and a hack saw is unhandy, and none too accurate, to say the least.

Set the work up between centers in a lathe, adjusted to run slightly eccentric. Then, using the threading gears and longitudinal feed set to the desired threads per inch, pitch, or in this case, distance between cuts, bring the tool in light contact with the work, and make the desired number of cuts. Center the work, disconnect the longitudinal feed, and make cuts the full circumference of work at specified intervals. Gage glasses can be marked in this manner, using a small tool post grinder, and knife edge wheel.

SAM WILLIAMS

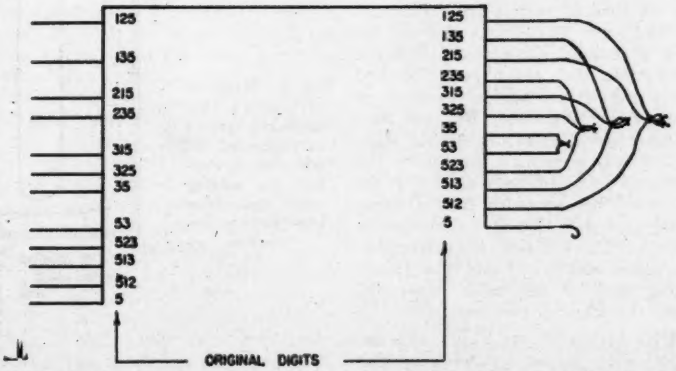
This Can Be Used On Right Hand Models Too

Last month on p. 88 we presented a problem by Charles V. Johnson dealing with the identification of a 12 conductor cable, the ends of which were on opposite sides of a deep canyon, involving a 7 mi. trip by trail from one side to the other. Mr. Johnson's solution, showing how the unidentified conductors may easily be tagged out by means of a buzzer with only one trip to the opposite end and back, is given below. Incidentally the cable was used by a farmer for the remote control of a left-hand, winter model Superskiliunkdum—things aren't what they used to be down on the farm.



FIRST STEP: Group wires as shown pigtailed together and then tag them accordingly.

SECOND STEP: Go to other end of cable and, with test buzzer, tag ends to correspond with first end.



FINAL STEP: Return to first end and, with test buzzer, identify wires and tag to correspond with End B.

THIRD STEP: Regroup, pigtail wires as shown, add digits to original numbers as per first and second steps.

Problem 22, A Hot Spot in the Ice Plant

How Would You Do It?

WORRYING about gas rationing and tires the venerable Judges, separately and independently, heaved a sigh, looked sadly in the garages at their 30 yr. old two lungers but wheeled out their bikes, slipped the clips on their beards and gayly peddled down to the Loop for their bi-monthly meeting.

"That," said the Oldest Judge peeking at Ed Podmayer's letter, "is a good idea. Bailiff, we must have a fan! Can't do a thing without it." While the office force was busy looking up WPB priority regulations on Fans for Contest Judges—the Judges themselves discovered the Youngest Judge had a lunch basket and they decided, with one dissenting vote, to finish the session after a picnic lunch in Grant Park.

That proved to be a tactical error. With the windy boulevards, the mummies in Field Museum, the octopus in the Aquarium, the Planetarium and the beach it was well toward sunset when the Chief Justice remembered the contest entries in his brief case. "Too dark outside now to see," said the Junior, whose grandpa fed salt to Mrs. O'Leary's cow before the Fire. "We should seek light and guidance at the Palmer House."

Beards flowing and in lock step they marched in, ranged around a table and had just spread out the entries when a cocktail glass stem shattered on the table. The eldest Judge jumped up and ran to the bar to remonstrate with a rude individual. By that time the man had drained his second Martini and was munching the top of the glass and just had time to throw the stem over his shoulder before being rushed out the door by a couple of huskies. "Crazy!" said the bartender. "No doubt about it," said the Judge, turning back to the table, "everyone knows the stem is the best part."

After several hours' study and discussion with no further interruptions the Chief Justice served up the verdict as, "Ray should have First Prize. His solution is practical and cheap. Furthermore he is a patriot—salvages a pump and leaves the way open for us to talk Our Hero out of the 3 by 3 compressor for air conditioning the Judicial Chambers this summer. Ed's solution sounds practical and is based on past experience, but it's not quite right to steal his wife's dishwasher at a time like this. Probably it's her kitchen fan he has his eye on too, so we'll give him only second place. Joe seems to know, too, but he's guessing that more pipe can be obtained, or, that it is already on hand or that it can be installed. He should have third prize."

"What," asked the Junior Judge, "about adding a larger brine pump to increase the brine velocity, or adding a brine pre-cooler, or, putting the small compressor on the holding rooms or half a dozen other suggestions?"

"The war, my boy, the war, Mr. Nelson and priorities, possible power shortages and good engineering—always do it the simplest way that will accomplish the purpose—thus I snap my fingers quietly. My night cap appears at my elbow—the check at yours —demonstrates the Conservation of Energy and the First Law of Economics."

FIRST PRIZE AWARD
Rembert Ray,
Chief Engineer, Imperial Ice Co.,
Ocean Park, Cal.

SINCE THE temperature difference between the brine and the desired room temperature as now operated is 12 to 14 deg., this would ordinarily give sufficient heat transfer to maintain a temperature of 30 deg., since the room is satisfactorily insulated. I suspect that the coils are pretty well loaded with ice most of the time and this reduces the heat transfer. You start to chisel off the ice with a bar while ice drips down your neck and you always get tired and disgusted before 10 per cent of the ice is removed.

By converting your brine coils to direct expansion coils your difficulty will be eliminated and at the same time you will save the power required to drive the brine pump. The 16 deg. normal brine temperature indicates an ammonia evaporating temperature of approximately 11 deg. (depending on the type of coils in the ice tank).

This ammonia evaporating temperature also would be established in the storage coils, giving a temperature difference between the refrigerant and air in the storage of 17 to 19 deg. thus increasing the heat transfer materially. Before re-connecting the coils they should be washed out with water and blown out dry with air.

As shown by Fig. 1 remove pipe A to B and C to D including the brine pump. Run a ¼-in. liquid line, E to C, and install a ¼-in. expansion valve F. Connect a 1¼-in. suction line A to G and install the ammonia valve H. By all means install a ½-in. defrosting line I to J and install a ½-in. ammonia valve K.

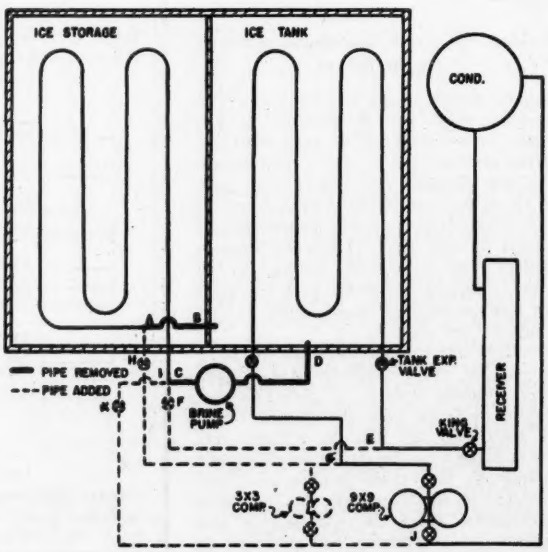


Fig. 1. Sketch illustrating the schematic lay-out as suggested by Mr. Ray to convert the holding room coils from brine to direct expansion

Install your 3 by 3 in. compressor as indicated on the drawing only if you desire a little more over-all capacity. In this case the discharge pipe between the two compressors should be ¾ or preferably 1 in. If you do install it put in a valve at L. By closing this valve you can run the 3 by 3 in. independently on the storage for any desired length of time to reduce the temperature further if desired.

Also the 3 by 3 could be used for defrosting, without running any other part of the plant. With no water running over the condenser, the head pressure would be higher and thus speed defrosting. If the head pressure should get too high, turn on condenser cooling water for a few minutes. Also use a 3 by 3 in. compressor to pump out the storage coils before connecting up the discharge.

Defrosting of the storage coils is very easily and efficiently done while plant is running as follows: Close valve H and F and open K allowing the hot discharge gas to flow to the storage coils, which temporarily acts as a condenser. If the coils condense full before defrosting is completed, open valve H a turn for a minute or two and then close.

If there is any tendency for liquid to slug into the compressor instead of trapping into the tank, close the compressor suction valve and open H wide for 30 sec., then close H, open the compressor suction valve and continue defrosting. There are several other details which might be added but which I feel quite sure are unnecessary.

SECOND PRIZE AWARD
Edward Podmayer
Teaneck, N. J.

THERE ARE any number of things to be done that may be of help to the Hot Spot in the Ice Plant. For instance, speeding up the compressor or pump or check the agitator in the ice tank where, I presume, the brine from the vault is cooled. I have had two experiences where I increased the refrigeration.

In the first case we were pumping brine from our ice tank to chill some boxes and in summer we had trouble holding temperatures. I checked the temperature of the brine in the tank and found that at the bottom of the tank the temperature was about 8 deg. above zero and at the top of the tank it ran from 14 to 18 deg. above.

This also caused a freeze back due to poor evaporation of our refrigerant. We had been depending upon the brine pump to give us enough agitation, but tests indicated otherwise. We had an old dishwasher pump and motor laying around and set this up on the tank. We dropped the suction line to within a few inches of the bottom and discharged the brine 4 in. from the top at the opposite end. This equalized our tank temperature and increased our refrigeration due to higher back pressure because of better evaporation.

In the second case, by placing a small fan in a cold storage vault to give circulation over the coils we were able to drop the temperature 7 deg.

THIRD PRIZE AWARD
Joseph Roy
Naperville, Ill.

INASMUCH as the large compressor mentioned in the problem should not be very heavily loaded under the conditions given, and the brine temperature can be held easily, I believe the difficulty in the freezer is in the amount of pipe.

For coolers of the size mentioned with brine it is customary to allow about 5 cu. ft. of space for each linear foot of 1¼ in. pipe, or about 8 cu. ft. per linear foot of 2 in. pipe. Our Hero should have, therefore, about 650 ft. of 1¼ in. pipe or about 400 ft. of 2 in. pipe.

With the insulation and construction mentioned, the heat loss under the most extreme weather conditions should not exceed about 9000 B.t.u. per hr. or less than 1 t. of refrigerating effect. Twenty gallons of brine should hold this with about a 1 deg. temperature rise. It is quite likely that the pump is not delivering anywhere near 20 g.p.m. and it would be well to check this up if possible. The time required to fill a calibrated tank, or even a barrel, is the easiest method with a very small pump of this kind.

In brine pipe for this service it is usual to allow a brine velocity of from 5 to 7 ft., a temperature rise of about 2.5 deg. F. and a heat transfer of about 2.5 B.t.u. per sq. ft. per hr. per deg. F. The heat transfer is of course materially decreased if the coils are allowed to ice unduly.

PROBLEM 23
OUR HERO TACKLES A MEAT PACKING PLANT

Down in Memphis Our Hero has a friend—an engineer in a small meat packing plant—who lately has been complaining about lack of boiler capacity during peak load periods, and an excessive amount of boiler feed make-up which complicates his water treatment.

"Nuts," says Our Hero. "You take all your process and cleaning water from the cold water lines and heat it with live steam in suction tees ranging from ½ to 1 in. You evaporate about 200,000 lb. of water per day in the boilers, and 18 out of 24 hr. you're wasting exhaust steam to the atmosphere. You have a 4 in. live steam line throughout the building supplying live steam for process and this is almost paralleled by another 2½ in. live steam line to the lard pump cookers, etc.

"You have enough old tanks, pumps and pipe around here to build a battleship. I'll fix you up to cut down on your steam load during the peak periods, increase your condensate return and at the same time, recover a large part of the exhaust steam you're now wasting and some of the heat absorbed in your ammonia condenser cooling water."

But again Our Hero stuck his neck out too far. When it came down to the details he was stuck—didn't know enough about packing house operation. Can you help Our Hero? After talking so big he doesn't want his Southern Friend to call him a Dam' Yankee braggart!

Write your opinion of this case in a letter of not over 1000 words and send it to the Contest Editor by July 31. A first prize of $15 will be awarded for the best letter; a second prize of $10 and a third prize of $5. Entries in this contest should be marked Problem 23 and addressed to the Contest Editor, Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill.

EDITOR'S NOTE: Just as we were winding the problem up and wishing the Judges had devoted a little more space to other possible solutions so as to fill up the page, in walks the postman with an entry from our old pal Peter "P&V" Squirt of Milwaukee.

The fact that he was more than 2 wk. late and that the Judges had long since finished with the problem, did not affect Pete's confidence for he added "P.S. Apply the First Prize of $15 to War Bonds." His suggestion of dealing with the problem follows:

"The insulation on the inside of the ice storage vault and the ante-room with the cooling system appear to be ample from the present knowledge of this art. So it comes down to the question of dealing with the outside only.

"It is assumed that the ice storage vault and the ante-room together with the roof are constructed of a good grade of concrete and it therefore is simply a matter of insulating this concrete and keeping it from absorbing heat during the day.

"Install a covered, insulated tank of cooling water in the ante-room, run a small diameter pipe from this tank to the roof with a perforated pipe along the high point of the roof. Use the small compressor as an airlift or pump to force the water up to the roof where it will pass through the perforated pipe and form a blanket of water over the roof and down the walls to be collected at the low point and returned to the tank for re-circulation.

"Pumping will only be required during the daytime as evaporation of the water from the concrete after the pump is shut off will act as a cooling agent in the evening."

Welding Tricks

By A. F. DAVIS
The Lincoln Elec. Co.

WELDERS throughout the country continually are thinking up short-cuts or kinks to speed production in arc welding. Two such tricks were used to good advantage in recent pipe line installations at the Cleveland Municipal Power Plant, Cleveland, O.[1]

Roll welding is a trick imported fr .m the oil fields, where long lines of pipe sometimes are welded in the downhand position entirely by rolling the pipe. Figure 5 shows a welder at the Cleveland plant using the technique in welding tube turns on pipe for water lines in the plant. Another picture of pipes being roll welded is shown in Fig. 4.

A neat kink is that being used by the welder shown in Fig. 3. This man is welding on the bottom side of a 10-in. water line with the aid of a mirror placed at an angle on the floor, so that the welder can see the point of welding. This stunt was used on all joints of a similar nature at the Cleveland plant.

In industrial maintenance work, the problem of removing broken stud bolts is frequently encountered. For a machinist, this operation takes about an hour, but two New York welders, Alex F. Morton and William F. Kramer, have developed a method by which the broken bolts can be removed in about 1/20 the time by using electric arc welding.

The method ordinarily used by machinists is to drill the stud with a small drill, following with a larger drill to remove as much metal as possible without touching the threads, and finally breaking out the thin shell with a small tool. The hole generally must be re-tapped, adding a fourth operation.

Morton and Kramer's method is to lay a nut above the broken stud (the inside diameter of the nut should be slightly larger than the outside diameter of the stud bolt), build the stud up with weld metal using the electric arc and weld it to the nut. The bolt then has a regular head and may be removed with an ordinary wrench.

In some cases a frozen stud will require heating of the area surrounding the bolt to expand it and permit the bolt to be removed, but often the welding operation itself will heat the area sufficiently to permit the removal of the stud as easily as an ordinary nut.

A typical broken stud problem is shown in Fig. 1. When the hardened studs are broken off level, a machinist will take about an hour to remove the bolt by drilling. If the stud is broken off on an angle, the machinist must take much longer for the drills will break, or run, on the slanted part of the stud. The welding method, developed and used by Morton and Kramer extensively since August, 1941, permits removal of an average of 20 broken studs per hour, whether or not they are broken off on an angle. A typical group of studs removed by the welding method is shown in Fig. 2.

[1]See Increased Electric Power for Cleveland, POWER PLANT ENGINEERING, April, 1942, p. 52.

Fig. 1. Removing broken studs is easy with welding. Some studs removed this way are shown below

Fig. 2. Six studs removed as desc.ibed in the text using nuts welded on as emergency heads

Fig. 3. Using a mirror to see for welding a joint underneath a pipe which cannot be rolled

Fig. 4. Another view of a welder roll welding a pipe

Fig. 5. Welder roll welds tube turns on a pipe

Bill Otto's Emergency Page

DEPARTMENT STORES, because of the large number of customers who cannot be trained but nevertheless must be protected and provided for, face a particularly difficult problem in connection with air raid training and precautions. At the Carson Pirie Scott & Co. store on State Street in Chicago, this is the responsibility of Chief Engineer William Otto.

As Building Control Director, he has perfected a storewide organization to handle emergencies, the entire program being coordinated with the city-wide program under the general direction and coordination of the OCD. Each floor of the store has a captain and under him a police, traffic, fire, first aid and mechanical squads. Through a special telephone switchboard in his office in the third basement Mr. Otto can talk direct to the floor captains, individually or collectively.

Power is purchased from the utility system, and although interruption is remote, it is always a possibility to be guarded against. As a precaution against this, a 10-kw., 110 v., d.c. generator (a rebuilt motor), driven by a rebuilt Ford engine, as shown by Fig. 2, has been installed to carry all exit and emergency lights, which are on a separate circuit independent of the other store lights. The engine, with an electric storage battery starter, can be started and will pick up the load in a matter of seconds. Cooling water is piped to the drain and the exhaust goes to a muffler in the basement below.

A special emergency truck, made entirely of scrap and salvage material, is shown by Figs. 1 and 4. It will pass through doors, and will go in the elevators so it can thus be taken quickly to any part of the store. In addition to two stretchers and tools, such as an axe, shovel, hoe, pike pole, crow bar, maul, wrenches, screwdrivers, pliers, etc., the truck carries a variety of equipment to meet any emergency.

This additional equipment includes: asbestos gloves; two kerosene and two electric lanterns; four hand and four large fire extinguishers; two gas and smoke masks; two pails of sand and a megaphone. The large tank is for water and is equipped with a nozzle for spraying incendiaries. The tank is kept charged to 60 lb. pressure by a motor driven compressor.

Except for a few odds and ends taken from the store stock, all parts used are reclaimed from scrap or salvaged and fabricated in the store by welding. Figure 3 shows an oxygen tank truck under construction. Ford wheels are used on both trucks. The old Ford front axles were shortened so as to pass through doorways by cutting out the center section and welding as clearly shown in Fig. 3.

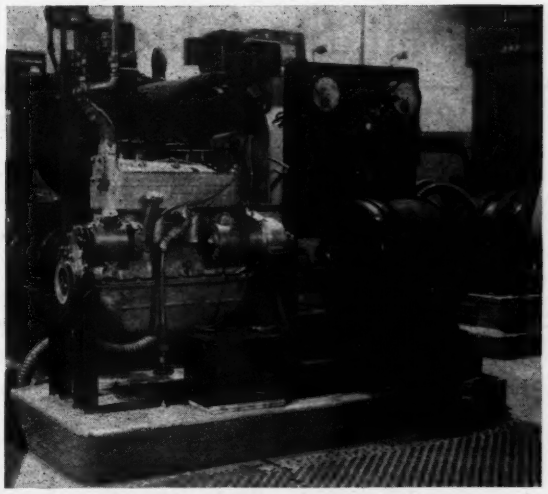


Fig. 2. A rebuilt motor, driven by a Ford engine serves as a 10-kw. d.c. generator, to carry the emergency lights should utility power be interrupted

Fig. 3. An oxygen tank truck under construction, showing the method of bracing, and the Ford axle shortened so the truck will pass through doors

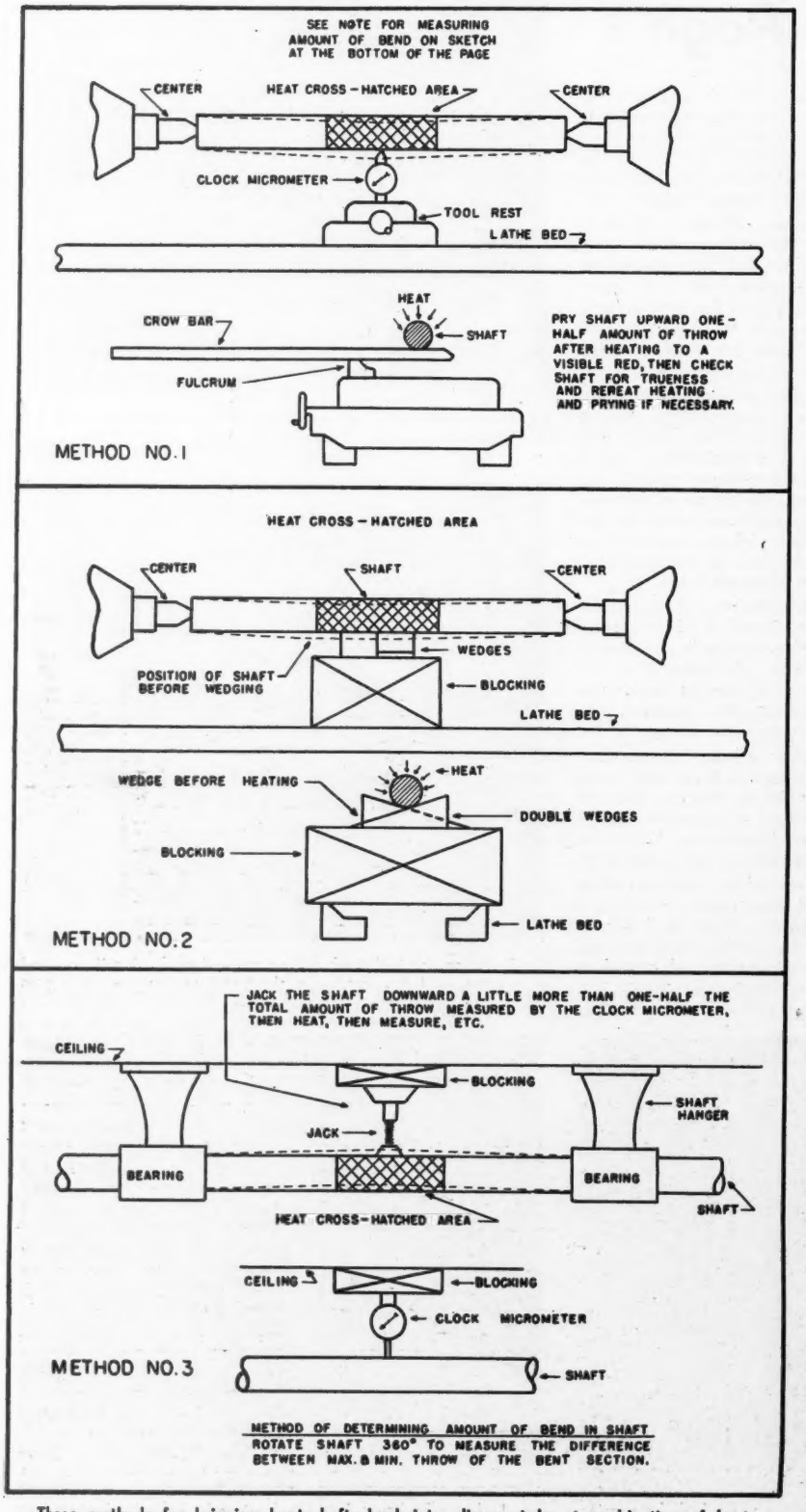
Fig. 1. Rear view of the truck showing the water tank, hose, extension cord and compressor used for charging the tank to 60 lb.

Fig. 4. Louie Paulsen swings the front end of the truck around to show the tools, kerosene and electric lanterns, sand pails, etc.

Shaft Straightening With The Blowpipe

By A. B. GORDON
The Linde Air Products Co.
Philadelphia, Pa.

While shafts and shafting can be straightened by either heat or pressure applied judiciously and separately, a combination of the two is usually more convenient and three different methods are illustrated and described by the author. For small shafts the straightening is facilitated by placing in a lathe. Long shafting can be straightened in position if the structure and bearing supports are secure



Three methods for bringing bent shafts back into alinement by a combination of heat and pressure

HEAT of the oxy-acetylene flame may be used to advantage in several convenient and labor-saving methods for bringing a bent or warped shaft back into alinement. A common procedure for shaft straightening is to set up the shaft in a lathe and rotate it in order to find the bent section and then measure the deflection as explained under Method No. 3.

When this section is determined, the outside of the bend is positioned at the bottom and heated with the blowpipe as shown in Method 1. Pressure is then applied to the heated area with a crowbar blocked up on the lathe bed to force the warped section back into line. If a single application does not correct the fault, the entire procedure is repeated until the shaft is perfectly true.

Alternate Method

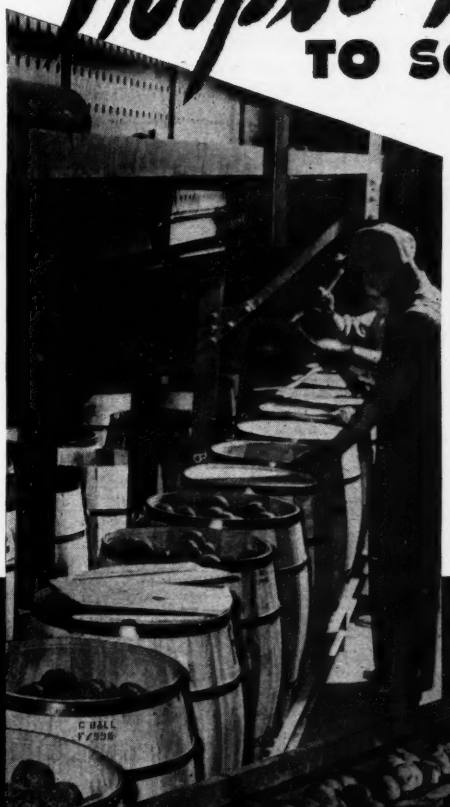
By an alternate method, the warped area is determined in the same manner. After measuring the amount of bend, a pair of wedges, as show in Method 2, of the correct size are driven between the outside of the bend and the lathe bed. The shaft is then heated at the inside of the bend so that the stress set up by the driven wedge will force the shaft back into alinement. Repetition of the procedure may be necessary to correct excessive warpage.

For Long Shafting

If the bent shaft is too long to be set up in a lathe, it may be left in its hangers. After checking of the hanger bearings to determine play or lost motion, firmness, and rigidity, a measuring fixture is set up to measure the amount of bend as shown by Method 3. The high spot is then heated with the blowpipe and forced back into line by means of a jack.

Triple Threat...

TO SCALE AND CORROSION



SYMBOLIC of this triple threat are the three endless belts shown here, rolling night and day to carry Nalco chemicals on the first lap of their journey to keep thousands of the nation's power plants operating at maximum efficiency.

Nalco moves forward against scale and corrosion with three main spearheads of attack: 1. *Field Surveys* by competent engineers who review conditions in your plant; 2. *Laboratory Research* by skilled technicians who analyze your water conditions and formulate the most effective treatment; 3. *Production of Chemicals* to meet your needs by men capable of translating laboratory formulae into carload shipments.

For water treatment to best meet your individual requirements, write today for a Nalco Survey of your plant.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Avenue, Toronto, Ontario

CONSERVATION CONTROL CARDS FOR TOOLS

While the proper handling and use of tools is important at all times, demands of the war program make it essential at the present time in order to avoid waste of tool steels. The two cards reproduced below with special permission of Henry Disston & Sons, Inc., are part of a series of 35 cards prepared as part of a widespread Conservation Control Plan.

The cards outline: typical troubles, causes and corrections; recommendations for selecting tools for different uses; how to use it properly; and, recommended speeds and feeds

Power Hack Saw Blades

How to obtain greater efficiency and make blades last longer.

FAILURE	CAUSE	CORRECTION
Pulling out at pin hole	Blade drawn too tight.	Reduce tension on blade. Allow just enough to hold it straight and prevent twisting.
	Blade twisting in cut.	
Premature wear	Feed too heavy.	Reduce . . . see recommendations on other side.
	Speed too great.	Reduce to recommended speed.
	Incorrect tooth spacing.	Use number of teeth recommended for material.
	Insufficient feed.	Increase feed as recommended.
	Dry cutting.	Use coolant.
Stripping teeth	Tooth spacing too coarse.	Use number of teeth recommended for material.
	Teeth too fine for material.	
Crooked cuts	Worn frame.	Check machine for wear and adjustment.
	Frame out of line with vise.	
	Blade loose in frame.	Adjust.
	Stock not tight in vise.	Inspect clamps and tighten.
	Feed too heavy.	Reduce . . . see recommendations on other side.
	Wornout blade.	Install new blade.
	Hard spot in material.	Start new cut. May require new blade.
Blades breaking	Insufficient tension.	Make adjustment.
	Tooth spacing too coarse.	Use number of teeth recommended for material.
	Feed too heavy.	Reduce . . . see recommendations on other side.
	New blade in unfinished cut.	Start new cut.
	Side strain on blade.	Worn out. Change blade.

RECOMMENDATIONS

MATERIAL	NO. TEETH PER INCH	STROKES PER MIN.	FEED
ALUMINUM	4-6	135-150	60 Pounds pressure
BRASS—CAST—SOFT	6-10	135-150	60 "
BRASS—CAST—HARD	6-10	135	60 "
CAST IRON	6-10	135	120 "
COPPER	6-10	135	120 "
TOOL STEEL	4-6-10	90	120 "
COLD ROLLED STEEL	4-6	135	150 "
HIGH SPEED STEEL	6-10	90	120 "
MACHINE STEEL	4-6	135	150 "
IRON PIPE	10-14	135	120 "
STRUCTURAL STEEL	6-10	135	120 "
TUBING—STEEL	14	135	60 "
TUBING—BRASS	14	135	60 "

Machinists' Files

How to obtain greater efficiency and make files last longer.

FAILURE	CAUSE	CORRECTION
Stripping teeth	Choppy or fast filing stroke.	Use long, steady, uniform stroke.
	Too coarse a file for the job. Or using wrong file.	Use finer cut. Refer to recommendations on other side.
	Too much pressure.	A new file bites into the work more easily. File lightly at first.
	Work held improperly.	Work to be filed should be held tightly in vise.
Premature wear	Improper pattern, size or cut of file.	Refer to recommendations on other side.
	Dragging file on return stroke.	Raise file slightly on return stroke.
	Filing too fast (or running work in lathe too fast).	Use long, steady, uniform stroke. Reduce speed so file does not slide or glaze.
	Too much pressure.	Ease up on filing stroke.
	File clogging.	Refer to recommended file and cut and use file card and brush.
	Rusty files.	Protect file when not in use.
	Careless handling.	Respect your file as a cutting tool and treat it accordingly.
Breakage	Cleaning file by knocking against vise or work.	Use file card and brush.
	Careless handling.	Do not drop or use as a lever for prying.
	Too much pressure.	On a new file apply light pressure. Ease up on filing stroke.
Clogging	Improper tooth and cut.	Refer to recommendations on other side.
	Soft or tough gummy materials such as lead, aluminum, etc.	Draw the file back lightly along the metal on the return stroke so as to clean the teeth.
	Too much pressure.	A new file bites into the work more easily and clogs. File lightly at first.
	General clogging.	Use a file card and brush to remove chips which lodge in the teeth. By chalking cutting teeth, clogging can be avoided, and smoother work produced with less scoring and stratching.

GUIDE FOR THE SELECTION OF THE PROPER FILE FOR THE JOB*

1. Roughing

where rapid removal of metal is the object. Bastard Files should be selected; however, where the work is of thin gauge or light stock, choose a Second Cut or Smooth File with teeth of finer spacing, for filing across the thickness.

Flat Surfaces—Flat, Hand.
Holes—Round, Square, Three Square, Half Round.
Corners—Round, Square, Three Square, Half Round.
Slots—Knife, Pillar, Warding.

2. Finishing

where work is to be smoothed or finished, select Second Cut or Smooth Files. All thin and hard materials require Smooth Files.

Flat Surfaces—Flat and Hand Smooth. A Mill Bastard or Mill Second Cut is more desirable for a very smooth finish.
Lathe—Mill, Flat.
Holes—Round, Square, Three Square, Half Round.
Corners—Round, Square, Three Square, Half Round.
Slots—Knife, Pillar, Warding.

*Machine Shop Files are divided into three degrees of coarseness, depending upon the spacing of the teeth into Bastard as coarsest, Second Cut as medium coarse, and Smooth as finest. With the exception of the Mill, Mill-Lathe, and Shear Tooth Patterns, all the files in this group are double cut.

A PAIR OF IRON BODY VALVES FOR CONTINUOUS SERVICE

Fig. 1640 I.B.B.M.
"KING-CLIP" GATE
(Non-ferrous stem-thread bushing cast in the bonnet)

Fig. 1644 All-Iron
"KING-CLIP" GATE
(Coarse integral stem-thread in bonnet with large clearance)

On lines where uninterrupted service is essential—which means *all lines* in these critical times—you'll do well to use these two sturdy Lunkenheimer valves.

They are built to stand up under rough, hard usage—to stay tight and to give the added long service life so necessary now when replacement time is so important.

You can use them to advantage in the many places where small gate valves are used. Fig. 1640 has wide application on steam, oil, gas, water and gasoline lines and Fig. 1644 on many corrosive lines.

Once installed, these quality valves will do their part well.

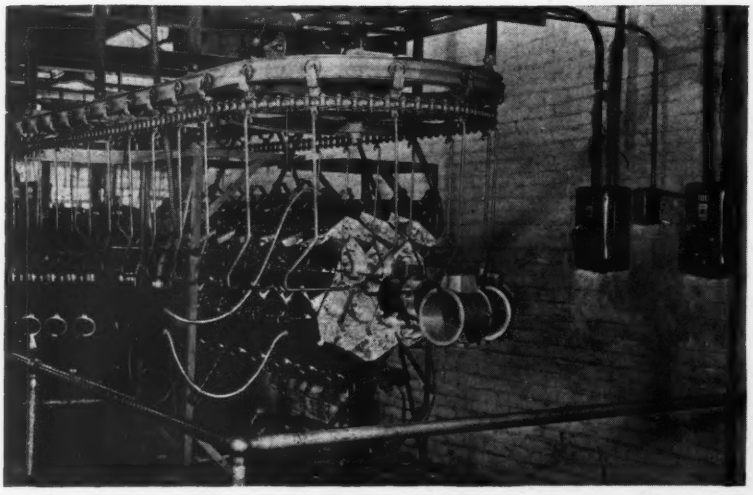
ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

Since virtually all materials used in the manufacture of valves are on the list of critical materials, valve users are urged to furnish the highest possible preference ratings on their orders. This will be of mutual helpfulness.

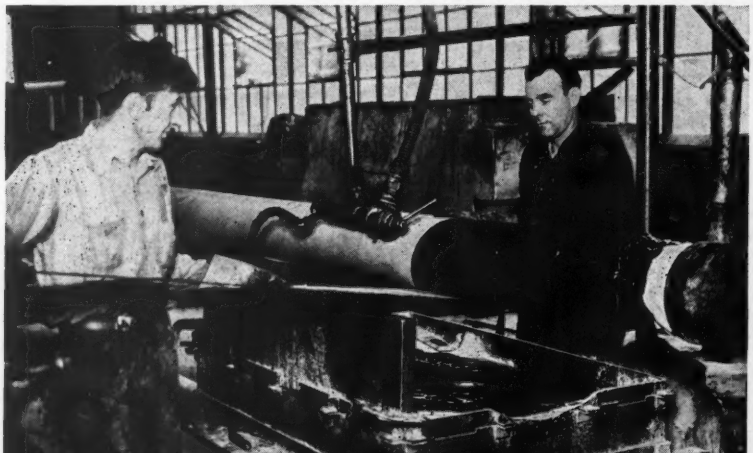
LUNKENHEIMER VALVES

SHOP TALK

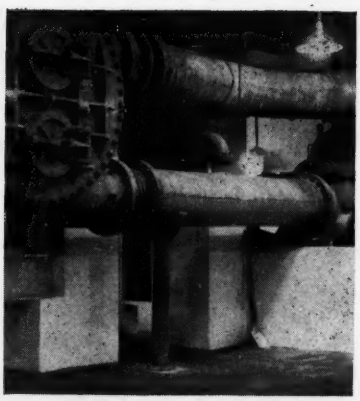
A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.



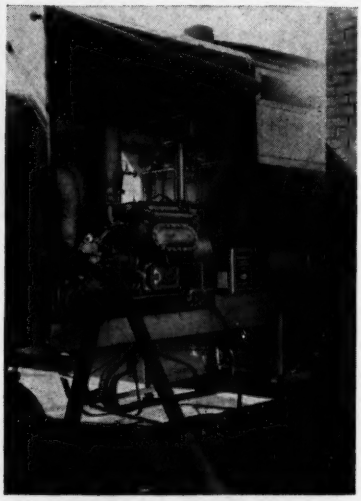
SHRINK FITS. If you don't like dry ice for shrink fits Fred C. Gossett, supervisor of Methods at the Westinghouse Lima plant has another suggestion—infra red lamp. The photographs show aluminum frames for small motors leaving the lamp banks. Heated up to 150 deg. C. the 6¾ in. bore expands 0.020 in. and allows the wound primary to slip in place. The battery has fifty-six 375 kw. lamps and the conveyor travels around 30 ft. per min.



WATERPROOFING PIPE. Here R. Fellenbaum (left) and J. O'Neil are wrapping helically corrugated Armco iron pipe in the Ric-Wil Co. shop at Cleveland, O., to make prefabricated underground conduits. First comes a bonding coat of asphalt applied at 400 deg. F. by the spray machine; then a second coat of asphalt somewhat over ⅛ in. thick; and while this is still hot a tension wrapped layer of 30 lb. asphalt soaked asbestos felt, (the dark section in front of Mr. O'Neil). Finally for protection during shipment there is a layer of heavy Kraft paper (the light section in between the two men).

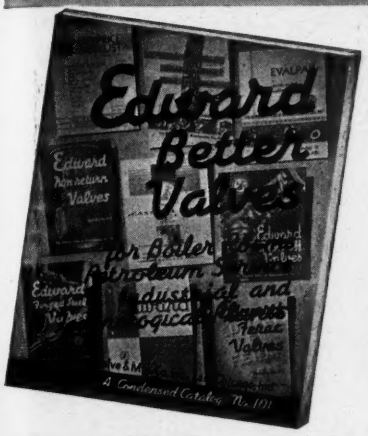


PIPE SUPPORTS. Circulating water piping is heavy and due to the use of expansion joints must be adequately supported. In this industrial plant the discharge pipe is provided with a good substantial crutch and the discharge pipe suspended from the ceiling. The condenser itself is supported on springs.



PORTABLE ICE RINK. A pipe dream of N. T. Todd of Indianapolis, Ind., became a reality last year when the Winterland Ice Review opened up at Connersville, Ind., on its own portable rink. This 35 t. York V/W compressor is driven by a V-8 Ford Mercury engine while Wisconsin single cylinder engines drive the condenser and brine circulating pumps. To make the installation independent of location cooling water can be supplied from a portable water tank. The rink floor of a radically new type has no piping and can be set up anywhere in a few hours. It consists of 500 lb. steel sections, 19 ft. 6 in. long, 2 ft. wide and 3 in. high with two connections, one to the brine supply, one to the return header. Clamped together these sections can be made to fit any space indoors or out. About 20 sprayings are necessary to give a perfect skating surface. Cracks between the sections, given a preliminary sealing spray, offer no difficulty in the way of a good surface for skating even under hard service.

On these Edward Valves - - - -
DELIVERIES WITHOUT DELAY



Today, more than ever before, it pays to use the Edward valve line. On many items . . for instance those illustrated here . . Edward is making prompt deliveries on proper priorities. Concentration on standard lines, increased plant capacity, and 'round-the-clock production has made this possible.
But there has been no compromise with the Edward tradition of quality. Today's Edward valves, whether for 150 lb or 1500 lb service, are built with the same painstaking care that has made Edward synonymous with low cost in the long run. You should have full details on the Edward line in your files. Have you?

DO YOU HAVE THIS HANDY CATALOG? . .

Edward Better Valves catalog No. 101 was compiled with an eye to today's problems. Complete but condensed to save your time, this highly usable handbook of widely-used Edward valves is packed with design and dimensional data and illustrations. It's yours for the asking. Write for Edward Better Valves Catalog No. 101.

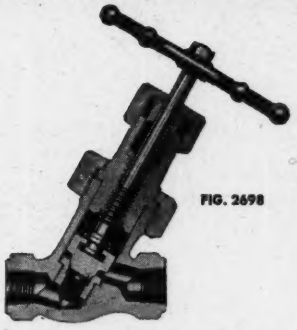
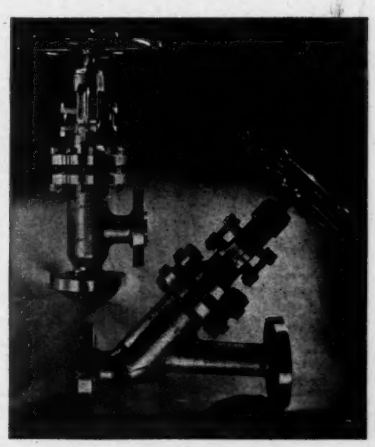


FIG. 2698

VERSATILE STOP VALVE . .

The best bet for a multitude of tough jobs —that's Edward Fig. 2698. Forged steel, inside screw, union bonnet, screwed ends. Full area, streamlined body minimizes pressure drop. EValloy seat and disk. Drop tight closure, easy operation. For 600 lb sp. at 750 F in sizes ¼ in. to 2 in. Fig. 2698 is globe, Fig. 2699 is angle. O.S. & Y. of similar design (Fig. 2688-9) also available.



BLOW-OFF EFFICIENCY . .

For tough blowdown jobs, count on Edward blow-off valves. Straightway or angle, shown above, for 150 to 1500 lb sp. Slow opening design avoids damaging shock to piping. EValloy or hard-surfaced seats and disks fight erosion and corrosion. Globe type seating design for tight closure with less leakage.

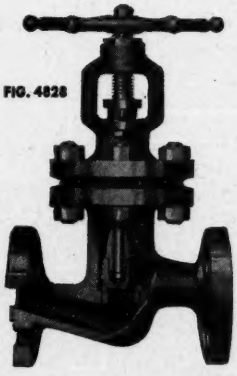


FIG. 4828

QUICK, SURE SHUT-OFF WITH EDWARD Fig. 4828 . .

Strong and reliable, Fig. 4828 is a flanged end leader in the Edward stop valve line. For pressures to 600 lb, this forged steel O.S. & Y. globe valve has bolted bonnet and bolted gland. Unique Edward swivel-plug type disk prevents galling, cuts maintenance, adds to valve life. Seats and disks are EValloy, Edward's specially developed stainless steel. Same design characteristics available in angle valves and for pressures to 1500 lb Sizes ½ in. to 2 in.

RELIEF! . . .

Edward forged steel relief valves. Relieving pressures to 600 lb for auxiliary steam lines, pump housings, heat exchangers and unfired pressure vessels generally handling water, oil or vapor. Globe or angle, screwed ends, sizes to 2 in. Stainless steel ball reseats tightly, no sticking. Vapor tight when relieving.

FIG. 141

INTEX STOP VALVE . . . . . .

Where elevated temperatures and high velocities tend to shorten valve life, Edward Intex globe valves offer opportunities for substantial savings. The seat is integral with the body and hard-surfaced with a tungsten-cobalt-chromium alloy. Disk also hard surfaced. Socket welding, flanged or screwed ends for pressures to 1500 lb at 950 F. Unusually easy to disassemble with all working parts readily accessible.

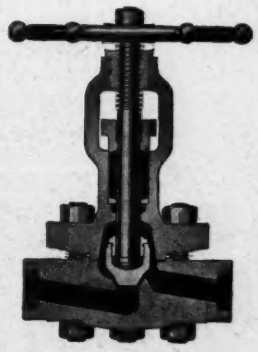
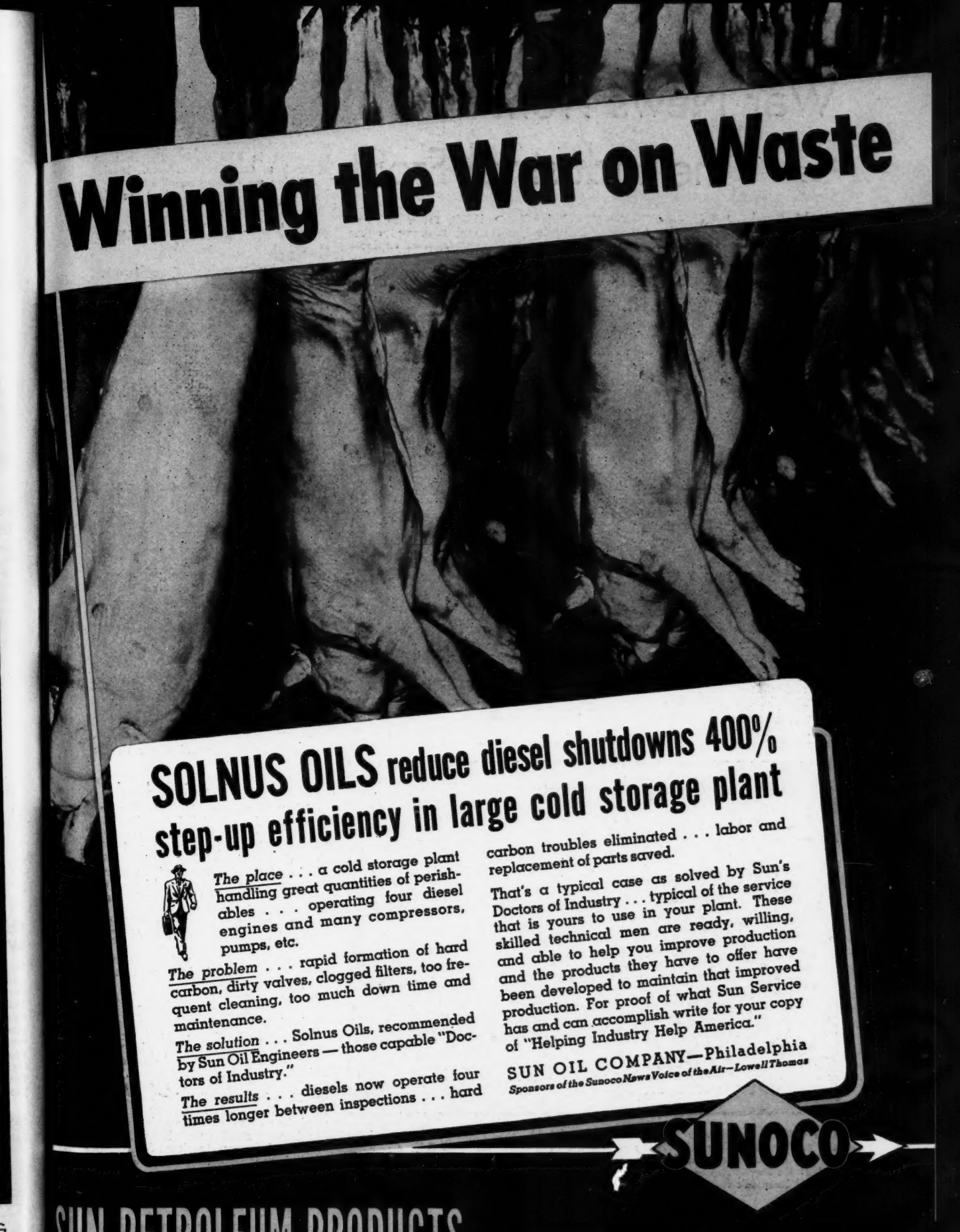


FIG. 3264

THE EDWARD VALVE & MFG. CO., INC.
220 WEST 144th STREET • • • EAST CHICAGO, INDIANA

EDWARD Steel VALVES
CAST AND FORGED

THE WAR PROGRAM
THE PRESIDENT
With the exception of the Armed Services, this chart shows only the offices established to be at the head of the emergency. It is not meant to imply that any of the Federal departments and agencies are not integral parts of the War Program
Compiled April 1943 by the United States Information Service. For further information see the United States Government Manual, for sale by the Superintendent of Documents, Washington, D. C., or write the United States Information Service Washington D. C.
WAR DEPARTMENT
DEPARTMENT OF THE NAVY
U. S. Marine Corps
U. S. Coast Guard
UNITED STATES MARITIME COMMISSION
SELECTIVE SERVICE SYSTEM
DEPARTMENT OF THE INTERIOR
Office of Petroleum Coordinator for National Defense
Office of Solid Fuels Coordination
EXECUTIVE OFFICE OF THE PRESIDENT
COORDINATOR OF INFORMATION
DEPARTMENT OF AGRICULTURE
Office for Agricultural War Relations
OFFICE OF CENSORSHIP
BOARD OF ECONOMIC WARFARE
NATIONAL HOUSING AGENCY
Federal Home Loan Bank Administration
Federal Housing Administration
Federal Public Housing Authority
JOINT BOARDS AND COMMITTEES
Permanent Joint Board on Defense - U. S. and Canada
Joint Economic Committee - U. S. and Canada
Joint War Production Committee - U. S. and Canada
Material Coordinating Committee - U. S., Canada and Great Britain
Combined Chiefs of Staff - United States and Great Britain
Munitions Assignments Board - United States and Great Britain
Combined Raw Materials Board - United States and Great Britain
Combined Shipping Adjustment Board - United States and Great Britain
Joint Mexican United States Defense Commission
Inter-American Defense Board
Pacific War Council
Division of Central Administrative Services
Division of Information
Counsel
OFFICE FOR EMERGENCY MANAGEMENT
OFFICE OF GOVERNMENT REPORTS
Coordinator of Government Films
DEFENSE COMMUNICATIONS BOARD
OFFICE OF DEFENSE TRANSPORTATION
OFFICE OF PRICE ADMINISTRATION
WAR PRODUCTION BOARD
WAR SHIPPING ADMINISTRATION
OFFICE OF LEND-LEASE ADMINISTRATION
OFFICE OF CIVILIAN DEFENSE
OFFICE OF DEFENSE HEALTH AND WELFARE SERVICES
WAR MANPOWER COMMISSION
OFFICE OF THE COORDINATOR OF INTER AMERICAN AFFAIRS
OFFICE OF FACTS AND FIGURES
OFFICE OF ALIEN PROPERTY CUSTODIAN
WAR RELOCATION AUTHORITY
NATIONAL WAR LABOR BOARD
OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT



Winning the War on Waste

SOLNUS OILS reduce diesel shutdowns 400% step-up efficiency in large cold storage plant

The place . . . a cold storage plant handling great quantities of perishables . . . operating four diesel engines and many compressors, pumps, etc.

The problem . . . rapid formation of hard carbon, dirty valves, clogged filters, too frequent cleaning, too much down time and maintenance.

The solution . . . Solnus Oils, recommended by Sun Oil Engineers — those capable "Doctors of Industry."

The results . . . diesels now operate four times longer between inspections . . . hard carbon troubles eliminated . . . labor and replacement of parts saved.

That's a typical case as solved by Sun's Doctors of Industry . . . typical of the service that is yours to use in your plant. These skilled technical men are ready, willing, and able to help you improve production and the products they have to offer have been developed to maintain that improved production. For proof of what Sun Service has and can accomplish write for your copy of "Helping Industry Help America."

SUN OIL COMPANY—Philadelphia

Sponsors of the Sunoco News Voice of the Air—Lowell Thomas

SUNOCO

SUN PETROLEUM PRODUCTS.. HELPING INDUSTRY HELP AMERICA

War News From the Industrial Front

Packing Plant Shares Machine Shop

THE JOHN MORRELL PACKING CO., operating plants in Ottumwa, Ia., and Topeka, Kan., recently embarked on a plan to further the war effort by allowing other manufacturing plants in these cities to avail themselves of Morrell shop equipment when not actually in use by the packing plants.

As explained by George M. Foster, vice-president in charge of operations, "No profit-seeking motive prompted the offer. Our only objective is to help speed the war effort. We asked only maintenance costs in return for the use of the machinery and the power necessary to run it."

The Morrell firm is busily engaged in production of meats for Army, Navy, and Lend-Lease commitments, and uses the machines 8 hr. daily, during which time their use is indispensable, and their offer for use during the other hours is looked on as a distinctly cooperative gesture.

Wood Water Tower Designs

DUE TO A decision by the War Production Board, priorities for steel to be used in the construction of water towers is not available. The Timber Engineering Co., Washington, D. C., has several timber water tank designs on hand and is distributing them free upon request. These designs range from 30 to 60 ft. in height, in capacities from 2000 to 100,000 gal.

The company also has completed a design for a 100-ft. tower to carry a 100,000 gal. wood tank and offers cooperation to any recognized engineer in designing tank towers, or, will examine designs submitted and give advice on the adequate use of the timber connector system of construction.

Siren Installation for Air Raid Protection

OFFICIALS and civilian coordinators who plan on purchasing an air raid siren in many cases overestimate the volume and penetrating qualities, according to E. T. H. Hutchinson of the Sparks-Withington Co., Jackson, Mich. The penetration of sound passes through some material and is absorbed by others, so the location, height, wind velocity and building obstructions must be taken into consideration when the choice is made.

Mounting a siren too high increases the sound range, but may cause the sound to skip certain areas in between. Usually to obtain the best results a siren should be mounted 30 to 40 ft. above ground level. Before a permanent installation is made, various heights should be tried out so that the best sound range will be developed according to the local requirements.

Ice Ceilings Adjusted

BECAUSE in certain sections of the United States the established practice of ice companies has been to have high prices during the heavier consumption period in the summer months, Price Administrator Leon Henderson has ruled that the price ceiling of March, 1942, would cause an unfair burden on the ice manufacturers.

Maximum Price Regulation 154, under certain terms and conditions permits the dealers to sell ice at the prices prevailing in 1941 during the months of April to October, inclusive. In the regulation which became effective May 25, the winter ceiling shall be the March, 1942, peaks.

Metal in Plumbing Fixtures Barred

AFTER JUNE 20, use of metals other than joining hardware, coating, or reinforcing mesh will be prohibited for use in plumbing fixtures in homes and commercial establishments. The action is expected to save 46,000 t. of iron and 7200 t. of steel annually.

While iron and steel are barred for use in plumbing fixtures their use is permitted in the following specified uses: shower receptors, 15 lb.; shower stall and receptor combinations, 25 lb.; grease interceptors, 5 lb.; plaster interceptors, 5 lb. and in septic tanks, the minimum required for reinforcement and connections.

A-10 Rating Needed For Instruments

ON A MOVE to conserve nickel, chromium and their alloys, the WPB has assumed control over the production and distribution of many types of instruments, regulators and control valves used in the manufacture of war material. Conservation Order L-134 drafted specifications for the various types of instruments and the restrictions on their use. Twenty-eight specific items are covered.

Effective immediately manufacturers can only deliver the instrument parts, no matter what their use is intended for, on preference rating A-10 or higher, but deliveries intended for the Army, Navy or Maritime Commission will not be affected by the restriction until 90 da. from issuance of the order, dated May 26.

Simplified Pipe Standards

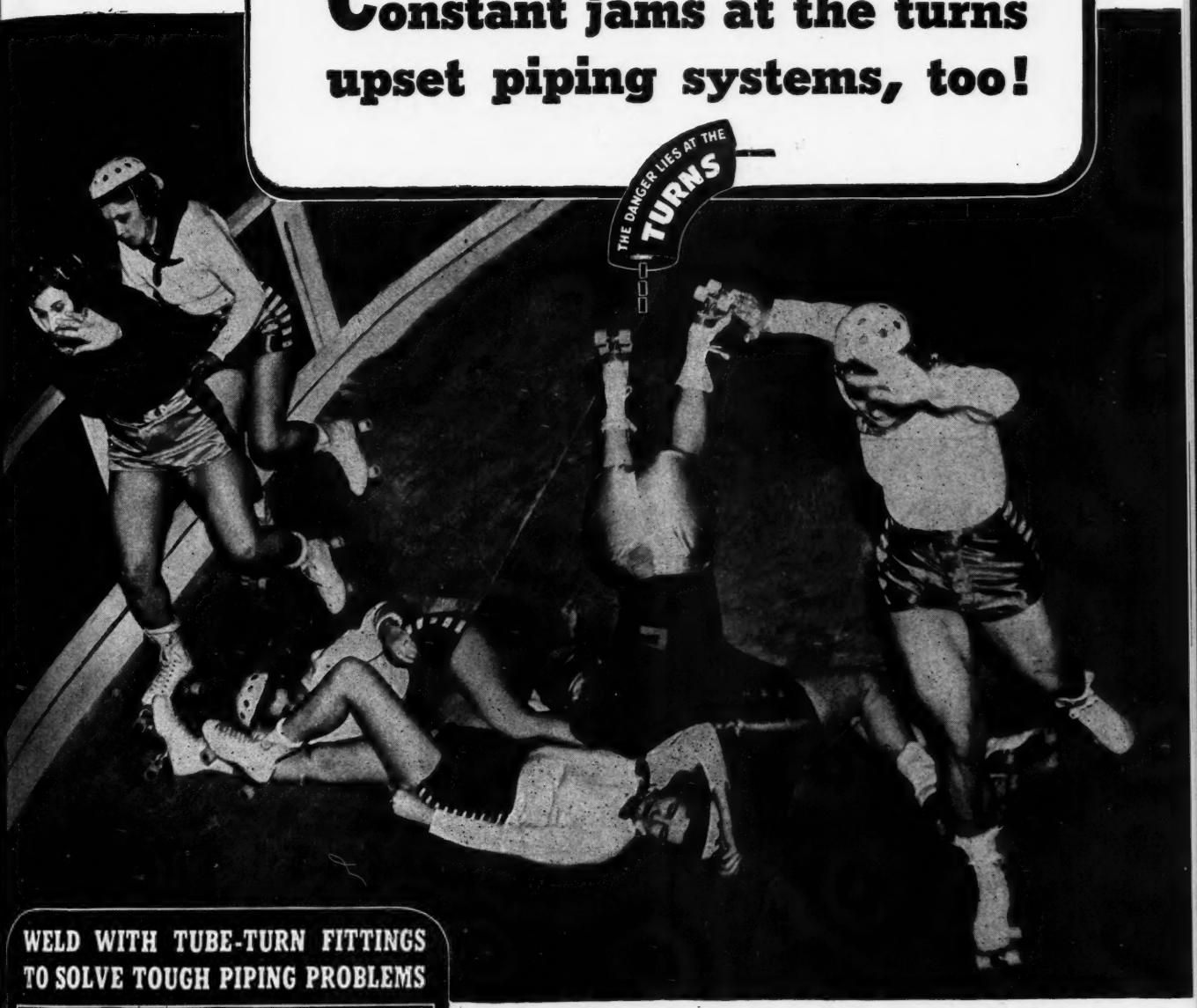
WITH THE approval of the Standing Committee for Simplified Practice Recommendation R57-32, Wrought Iron and Wrought Steel Pipe, Valves, and Fittings, the Division of Simplified Practice of the National Bureau of Standards has submitted a proposed revision of the recommendation to all interests for consideration and acceptance.

Promulgated originally in 1926, this recommendation established a simplified schedule of 49 sizes of pipe in the standard, extra strong and double extra strong weights. This figure represented a reduction of 21 per cent from the 62 sizes then being manufactured. In 1932 the recommendation was revised by the elimination of the 3½ in. size pipe in the double extra strong weight, and the current revision consists of the elimination of the 3½ in. size pipe in the other two weights, standard and extra strong.

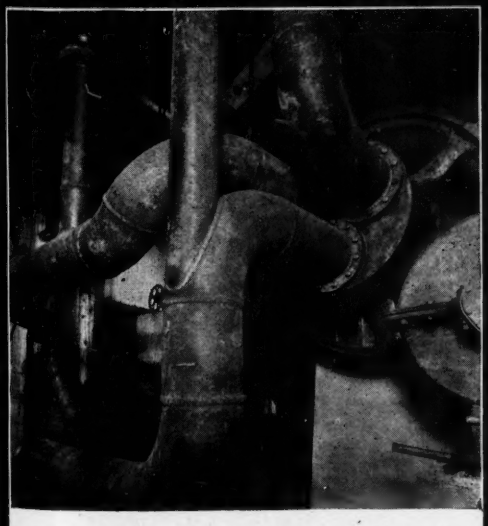
The present revision was proposed by the Manufacturers' Standardization Society of the Valve and Fittings Industry, and is based on a sampling which showed a relatively small demand for 3½ in. valves and fittings. In view of the small demand, and the need for simplification and consetvation in the present emergency, the Society suggests the eliminating of the 3½ in. pipe.

View in the Foster Wheeler Corp. shops at Carteret, N. J., as more than 2000 employes and guests gathered for the official award to the company of the Navy E for excellence. For over 50 yr. the company has been supplying equipment for the Navy Yards and ships. In 1891 the New Jersey shops built the condensers for the armored cruiser New York, later Admiral Sampson's flagship at the Battle of Santiago. Four men in the organization have worked there through three wars

Constant jams at the turns upset piping systems, too!



WELD WITH TUBE-TURN FITTINGS TO SOLVE TOUGH PIPING PROBLEMS



In this process industrial plant, the double problem of complete protection against leakage and other possible piping failures plus the necessity of a compact piping layout, is easily solved with Tube-Turn welding fittings. Tube-Turn fittings offer the advantages of greater strength and safety, faster installation, less weight, less pressure loss, less space occupied, and a full line of fittings for every welding piping need.

Tube-Turn Welding Fittings protect your piping where it counts most!

At a roller derby, people rush to get seats near the turns for the thrills are there! It's at the turns where the speeding skaters bunch up and try to cut off opponents—it's here where crowding the turns means trouble. The same hazard exists in piping systems at the turns, for pressure and strain are proportionately increased wherever flow direction is changed. That's why welding with Tube-Turn fittings is the best possible protection against piping failures occurring where the danger is greatest—*at the turns.* There is a Tube-Turn welding fitting for *every* piping turn!

Write for helpful Tube-Turn data book and catalog.

TUBE TURNS, INC., LOUISVILLE, KY. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles, Washington, D. C. *Distributors in all principal cities.*

TUBE-TURN TRADE MARK — The FIRST WELDING FITTINGS 1ST AND STILL THE BEST — *Welding Fittings*

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Liquid Leak Sealer

COLORLESS liquid leak sealer announced by the Flexrock Co., 23rd and Manning Sts., Philadelphia, Pa., offers a quick way to stop leaks in concrete walls, tunnels, floors, tanks and pits. The liquid chemical is mixed with ordinary

Portland cement, molded into a carrot and forced into the leak opening. The leak is said to stop immediately, even against intense pressure. Where dampness or seepage exists, an application of plaster coat of the same material is said to make the surfaces bone dry.

Air Raid Equipment

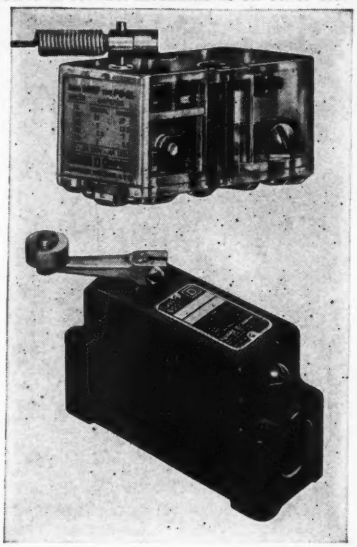
AIR RAID equipment recently announced by Specialties Mfg. Co., Inc., 35 Farrand St., Bloomfield, N. J., includes the stirrup pump barrel and the sand barrel truck. The barrel pump extinguisher consists of a 20-gal. barrel, mounted on wooden wheels in such a

manner that it can be trundled to the place of use. Two handles are conveniently attached so that two people can carry it from floor to floor. The top of the barrel is fitted with a hinged cover so that the water can be poured into the barrel. A stirrup type of pump is fitted into the top of the barrel and attached to a 12-ft. length of hose with an adjustable spray nozzle. To the side of the barrel there is conveniently attached an axe for use as required. The entire assembly can be obtained painted in bright yellow or luminous paint. The advantages of this barrel type stirrup pump are said to be its larger water capacity, convenience in trundling it to point of use and its simplicity of assembly.

The mobile sand barrel is equipped with an open top barrel of approximately 2½ cu. ft. capacity. Suitable handles are provided for two people to carry the barrel up or downstairs. A long handled shovel and an axe are provided for required use. Like the stirrup pump barrel the sand barrel is mounted on wheels and is painted a bright yellow, or with luminous paint.

Small Precision Limit Switches

CLASS 9007 Type P small precision limit switches, designed specifically for use where space and operating force are limited on modern machine tools, or as built-in contact mechanisms on other elec-



trical devices, have been announced by Square D Company, 4041 N. Richards St., Milwaukee, Wis.

Basic switch units 2 in. long by 1 in. square are enclosed in transparent molded polystyrene cases, sealed against tampering, yet allowing visual inspection of contacts. The operating lever can be adjusted to any position in a complete circle. Fifteen deg. travel is sufficient to operate the switch and the lever permits an additional 40 deg. emergency overtravel in either direction.

Die-cast enclosures for surface mounting types are 3⅞ in. by $1\frac{7}{16}$ by $2\frac{1}{32}$ in. A flush type arrangement is also available, permitting the switch to be built into the machine casting. Either push rod or roller arm actuators are used. Enclosed type switches require only 5 deg. rotation for operation and provide for 25 deg. emergency over-travel in either direction. The return spring is readily shifted to reverse contact action or provide latch type operation.

Controller

A NEW controller, Tag. No. 42, has been recently announced by C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. The control is compact and designed so that the few simple parts are accessible. The

controller has two gages inside the case, an air gage indicating the air pressure on the diaphragm valve, and another showing the pressure on the supply line. Air supply of 15 lb. is required for operation. The controlled air gage shows the throttling position of the diaphragm valve.

Long-Nose Cutter-Retriever

COMPACTLY designed to cut wire with one-handed one-fingered trigger operation, also to retrieve or to hold in a powerful grip nuts, bolts, washers, cotter pins, etc., at inaccessible points, the Alpert Long-Nose Cutter-Retriever will be distributed by the Pack-Rite Machine Corp., 828 N. Broadway, Milwaukee, Wis.

This cutter-retriever resembles a pistol, the cutting edges being located at the end of the long slim barrel. To cut wire, the operator places the wire between the cutting edges at the business-end of the pistol and snips off the wire by bringing down the trigger which actuates a rod operating inside the barrel. The leverage ratio is 15 to 1, practically no thumb pressure is required on the trigger.

To retrieve a bolt, nut, washer, cotter pin, etc., which may have dropped into an inaccessible place, the long-nose barrel is merely poked into the hard-to-get-at place, the trigger brought downward and the hardened steel cutters pick up the missing part. The cutter-retriever is light weight, flat, easy to slip into a belt or holster.

THE *Gilmer* NATIONAL POWER-RECOVERY PLAN

WAR PRODUCTION BOARD
WASHINGTON, D. C.

IN REPLY REFER TO:
154

April 23, 1942

AIR MAIL - SPECIAL DELIVERY

Mr. John S. Krauss, President
L. H. Gilmer Company
Tacony
Philadelphia, Pennsylvania

Dear Mr. Krauss:

After reviewing the essential elements of the proposed GILMER PLAN and considering the contribution it should make in the conservation of certain critical materials, and also in the important matter of conserving industrial power, we can advise that the Plan is in keeping with the general aims and objectives of the Industrial Salvage Section of the War Production Board, and we are glad to express our appreciation of your efforts in this direction.

The job of conservation and salvage of materials, machinery and supplies, along with the prevention of power losses, is one of the most important facing American industry today.

Very truly yours,

George T. Weymouth

George T. Weymouth, Chief
Industrial Salvage Section
Bureau of Industrial Conservation

COVERS—

- ELECTRICITY
- STEAM
- WATER
- MECHANICAL POWER
- REFRIGERATION
- COMPRESSED AIR
- BOILER ROOM
- PRIME MOVERS

"It's OK, *Gilmer!*"
says WPB

INDUSTRY'S vastly accelerated pace is turning power into Strategic Material No. 1. For the success of the war effort, Industry must salvage its tremendous power-wastes, and *use* that power for war production!

To help accomplish this urgent task, Gilmer, in collaboration with leading power engineers, has developed the National Power-Recovery Plan. This Plan is practical and workable, pointing out plainly just *where* and *how* power can be saved with a minimum of time and effort.

Authorities on power estimate that, if the Plan is adopted by America's industrial plants, the resultant power-saving will equal the combined output of two Boulder Dams! Translate that power in terms of *more* warplanes and tanks!

Here's the long-awaited chance to get an official "Go-Ahead" in your battle against power-waste! Show this advertisement to the responsible executive in your plant and get his support. Then put the Power-Recovery Plan to work! It comes completely packaged in a special Booklet. Write to Gilmer for a copy.

★ **L. H. GILMER COMPANY, Tacony, Philadelphia, Pa.** ★

The oldest firm of rubber fabric belt specialists

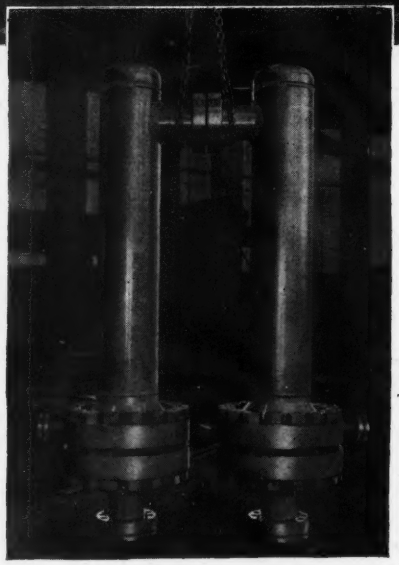
TOUGHEST PIPE ASSEMBLIES "Come in Packages"!

High-pressure sub-assemblies like this are delivered to installation sites, underwriter-approved.

Your new power-piping installations can be obtained with no more difficulty or personal attention than any *factory-made* item of major equipment!

Prefabrication by Grinnell takes over all the tough fabrication work . . . performs it better and faster . . . delivers the complete job in convenient "packages" consisting of sub-assemblies ready for immediate field hook-up!

"Give the Plans to Grinnell" when your piping requirements are roughed out. Grinnell engineers are equipped by long experience to interpret power and processing layouts into super-piping systems. Grinnell plants, strategically located to serve war industries, have every last facility to prefabricate simple and complex sub-assemblies . . . accurately, efficiently, in least time.



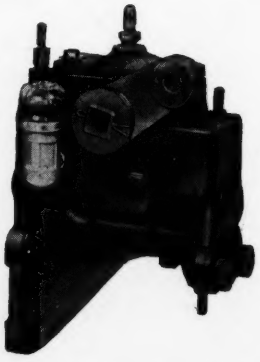
Get the complete story of this detail-saving service. Write for photo-facts booklet, "Grinnell Piping Prefabrication". Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

PREFABRICATED PIPING BY GRINNELL

WHENEVER PIPING IS INVOLVED

Automatic Oiler for Door Checks

To PREVENT waste of large quantities of oil, cleaning and decorating expenses, and elimination of fire hazards, elevator door checks with Trico visible automatic oilers have been announced by the Trico Fuse Mfg. Co., Milwaukee, Wis.



This controlled method of oiling is said to supply only the required amount of oil at the right time. Installation can be made quickly and no attention is required except to keep a supply of oil in the reservoir. A crystal-clear bottle tells at a glance when refilling is necessary.

Air-Raid Siren for Indoor Use

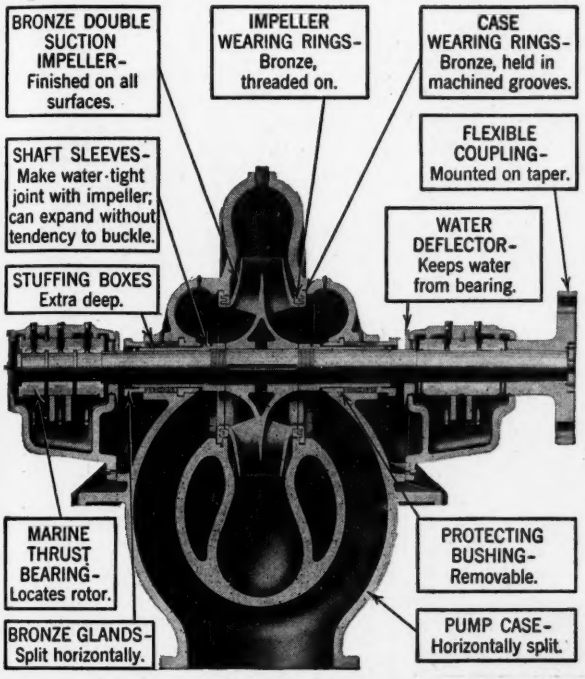
A NEW TYPE air-raid warning signal for industrial use is announced by the Breuer Electric Mfg. Co., 5100 Ravenswood Ave., Chicago, Ill. The difficulty of hearing a siren inside the plant is obviated by this new development in design. Equipped with a Universal a.c. or d.c. motor, the Tornado Air-Raid Siren operates on ordinary light current and is available for either a vertical or horizontal mounting base.

Bomb and Fire Extinguisher

FOR USE in extinguishing magnesium bombs and fires, a new product, Cend-Ex, is now being marketed by the S. Obermayer Co., 2563 W. 18th St., Chicago, Ill. Cend-Ex is a granulated coal tar pitch and is said to be most effective in dealing with magnesium bombs and fires. It comes packed in 12½ lb. rectangular tubes which can be hung on the wall or placed at strategic points in a factory, ready for instant use. The tube is 30 in. long—thus enabling the operator to work well away from the bomb or fire. Included with each tube is a placard of complete directions showing how to deal with bombs or fires of this type.

SUSTAINED EFFICIENCY

OF DE LAVAL PUMPS


BRONZE DOUBLE SUCTION IMPELLER- Finished on all surfaces.
IMPELLER WEARING RINGS- Bronze, threaded on.
CASE WEARING RINGS- Bronze, held in machined grooves.
FLEXIBLE COUPLING- Mounted on taper.
SHAFT SLEEVES- Make water-tight joint with impeller; can expand without tendency to buckle.
WATER DEFLECTOR- Keeps water from bearing.
STUFFING BOXES Extra deep.
MARINE THRUST BEARING- Locates rotor.
PROTECTING BUSHING- Removable.
BRONZE GLANDS- Split horizontally.
PUMP CASE- Horizontally split.

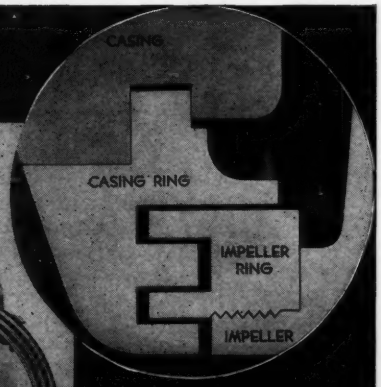
is due to proper hydraulic design, which avoids cavitation and pitting, and particularly to renewable *LABYRINTH WEARING RINGS*, which protect casing and impeller from erosion and reduce leakage from discharge to suction.

With De Laval *LABYRINTH RINGS* there is only about one-third as much leakage as between plain rings having the same radial clearance, or for the same initial efficiency De Laval pumps can have greater clearances than can pumps with flat rings. Because of the reduced leakage there is less erosion of De Laval rings than of flat rings and efficiency is better sustained. De Laval pumps which have been in continuous service for many years without renewal of parts still equal their original efficiencies, as demonstrated by numerous tests.

All parts of De Laval pumps are interchangeable on a limit gage basis and renewals ordered by number require no fitting.

State your pumping conditions and ask for Publication P-3222.

Three De Laval units in a water works plant. The largest, rated at 38,000 g.p.m. against 160 ft. at 600 r.p.m., showed on the acceptance test an overall efficiency, including motor, of 88.0 per cent.



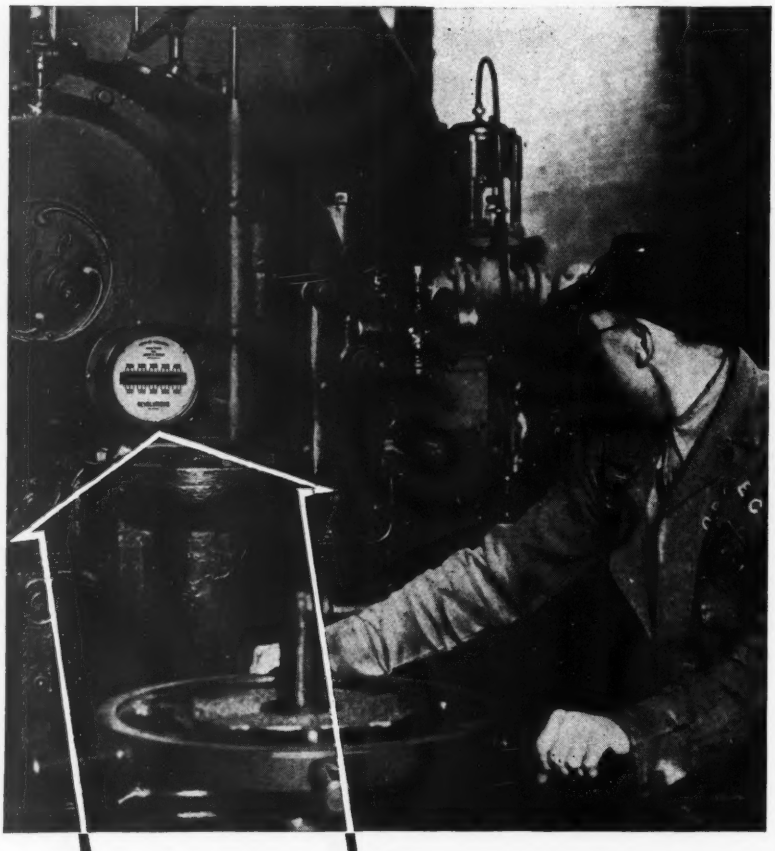
Section through labyrinth wearing rings.

Labyrinth case protecting ring.

DE LAVAL Steam Turbine Co.
TRENTON, N. J.

MANUFACTURERS OF TURBINES · STEAM HYDRAULIC PUMPS · CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT · MOTOR-MOUNTED · MIXED FLOW · CLOGLESS · SELF PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS · GEARS · WORM · HELICAL and FLEXIBLE COUPLINGS

"FRAHM" TACHOMETERS



A TACHOMETER . . . THAT WILL NOT WEAR OUT!

The Frahm Vibrating-Reed Tachometer does not even have to be oiled because it contains no gears, bearings, rotating or other wearing parts. *There is literally nothing to wear out.* It has no electric system—merely a set of accurately tuned reeds which vibrate by resonance according to the speed at which the machine on which it is mounted is running. Merely attach the Frahm Tachometer in almost any convenient location; the vibration in the running machine does the rest.

For more than 30 years we have supplied these unique speed indicating devices for use on turbines, generators, motors, centrifugal pumps and blowers. Ranges are available from 900 up to 15,000 r.p.m. Write today for descriptive Bulletin 1590-PE.

★

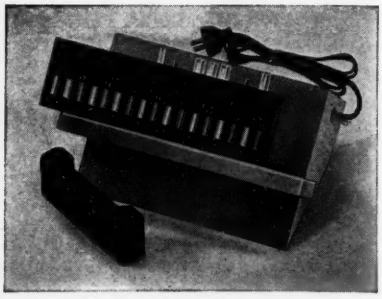
★In addition to the fixed-mount Frahm Tachometers, the portable type illustrated at the left finds wide use throughout industry for r.p.m. speeds. Rates of vibration such as in pneumatic hammers, drills and airplanes can be quickly determined by merely placing the Tachometer case in contact with the unit under test. Full details are included in Bulletin 1590-PE.

James G. Biddle Co.

1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

Midget Dalite Lamp

IN MANY laboratories and plants it is almost impossible to obtain a clear daylight background because of walls, trees and other obstructions. To overcome this possible cause of error the Taylor Midget Dalite Lamp announced by the W. A. Taylor & Co., Baltimore, Md. was designed for use with single Taylor Slide Comparators when determinations must be made at night or in dark places, and is said to be ideal for all routine testing even in daylight.



The comparator base is placed on the shelf at an angle of 45 deg. so that, in making readings, one can look directly into the slots in the slide and base. This eliminates handling the outfit, with possible chance of breakage, as only the sample tubes need be handled. The lamp gives uniform Dalite conditions at all times. It is fitted with a Dalite glass, special bulb, cord and switch and operates on any 110 v. circuit. It can be used with any Taylor pH, chlorine or phosphate comparator.

New Plug-in Duct

TO MEET the increased demand for electrical energy in the plant today, Square D Co., Switch & Panel Div., Detroit, Mich., announce the Saflex Plug-in Duct. The new duct is available in 250, 375, 500, 750, and 1000 amp., in 2 and 3-wire single-phase, 3-phase, and 4-wire service.

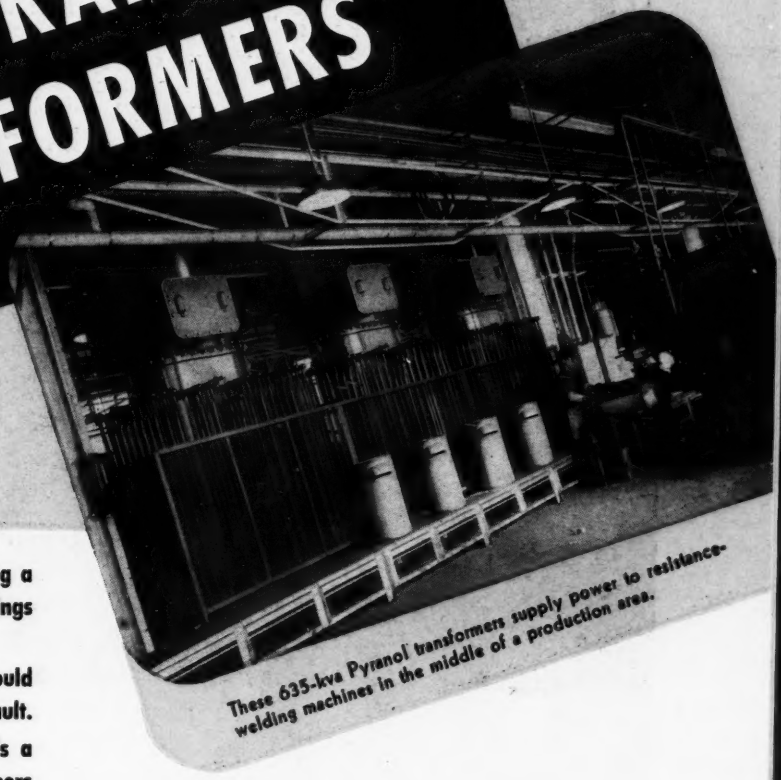
Tubular buses are used in 250, 375, and 750 capacities, and solid round bus bars for 500 and 1000 amp. Six openings are provided on each side of a 10 ft. length of the Saflex Duct and will accommodate 12 plug-in units.

Pumping Unit

A COMBINATION rotary - centrifugal dual pumping unit has been added to the Blackmer Line of pumps, as announced by Blackmer Pump Co., Grand Rapids, Mich.

The new unit, mounted on a cast bedplate, is powered by a 4-hp., 3-phase, 60 cycle motor with a gearhead on one end to drive a rotary pumping unit, and a shaft extension on the other end, connected direct to a centrifugal pump. The rotary pump has a capacity of 44 g.p.m. at 50 psi. handling lube or fuel oil. The centrifugal pump has a capacity of 75 g.p.m. at 25 psi. handling water.

TO THE HUNDREDS OF NEW USERS OF PYRANOL TRANSFORMERS



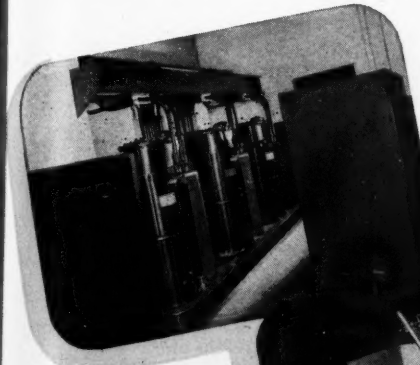
These 635-kva Pyranol transformers supply power to resistance-welding machines in the middle of a production area.

By installing Pyranol transformers (instead of making a conventional transformer installation) you made big savings in materials and over-all installed cost.

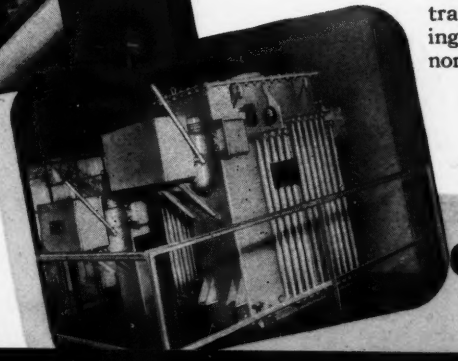
You reduced installation time and cost, because you could install these transformers indoors without a fireproof vault.

You saved copper—many tons of it if your plant is a large one—because you could install these transformers right at load centers, where transformers were meant to be installed.

You reduced line losses and voltage drop in your plant circuits and assured better performance from motors, resistance-heating equipment, lamps, and other electric equipment.



Vaultless installation of these 225-kva Pyranol transformers in a steel-mill motor room meant savings in materials plus economical power distribution.



These G-E load-center unit substations, incorporating Pyranol transformers, are part of a G-E load-center power-distribution system in an expanding war plant.

Safety of Pyranol—an Asset to Your Plant

Since the introduction of Pyranol in 1932, more than 4,000,000 kva of new transformers have been furnished with this type of noninflammable insulating and cooling liquid. No Pyranol transformer, in 10 years of operating experience, has burned or contributed to a fire.

Greater Reliability—a Continuing Benefit

The high dielectric strength of Pyranol means extra stamina to resist damage from voltage surges resulting from switching operations or lightning. This is a safeguard against progressive deterioration of the insulation that might otherwise result in a transformer breakdown and loss of power service.

Pyranol transformers have other features that mean greater reliability and little maintenance. The pressure-tight steel tank protects both liquid and solid insulation—keeps out dust, dirt, moisture, and other enemies of transformer life. Pyranol is nonoxidizing and nonsludging. It will retain its insulating properties over years of normal operation. *General Electric, Schenectady, N. Y.*

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

402-61-5106

DART UNIONS

HAVE LONG LIFE LINES

...To conserve vital metals put your Used Darts back to work

In these times, when the conservation of vital metals is not only important but necessary, you can help your Government and your plant by letting *used* Darts work side by side with *new* Darts.

You will find that the "old-timer" Darts will make up tight quickly and easily and stay tight unfailingly . . . like new Darts. The complete explanation why Darts can be used again and again with such satisfaction lies in the way Darts are made: their matched bronze seats, ground to "true-ball" surfaces; their air-refined malleable iron nuts and bodies that resist corrosion, rust and rough handling.

Yes, used Darts are "treasures" today—so "dig them up" and put them back to work. And for *new* Darts, see your supplier today.

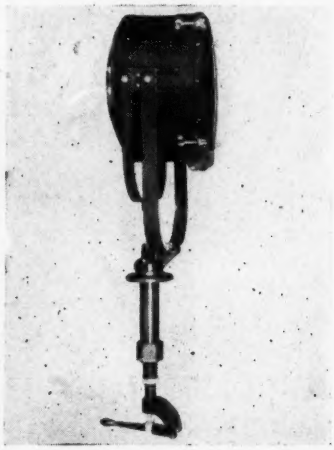
DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Searchlight

A NEW 18-in. incandescent searchlight with pilot house control or flat base, is announced by the Westinghouse Lighting Division, Westinghouse Elec. & Mfg. Co., Cleveland Ohio.

Intense beam concentration is obtained by a primary precision-ground and polished silvered-glass reflector and a metal secondary reflector to permit continuous operation with lamps up to and including 1500 w. A tandem reflector shield, mounted in the center of the primary reflector eliminates all secondary heat concentration on the lamp bulb. Heat dissipation is by radiation, permitting a dust-tight enclosure.



The lens is of heat and impact resisting polished glass mounted against a weather-tight gasket and held in position by steel spring clips. Primary reflector is a 19-in. parabolic commercial-precision mirror coated with silver and sealed by an electrolytic coating of copper and synthetic material. Secondary reflector is of polished metal too and provides high reflectivity. Socket assembly is the standard mogul bipost-type rated at 50 amp., 600 v. It is normally fixed in position but is independently adjustable for elevation and rotation.

High Temperature Stack Coating

A NEW corrosion and heat resistant stack coating for all types of industrial stacks, furnaces and boiler room applications has been announced by the Carbozite Corp., Pittsburgh, Pa. Known as Carbozite High Temperature Stack Coating, this new product is said to withstand temperatures up to 900 deg. F. without sagging or deteriorating and provides complete protection against corrosive atmospheres and materials including acids, alkalies, sulphur fumes, by-product gases, salt air or water and ordinary moisture.

It is available in two colors, red or black, and in weights suitable for brushing or spraying. Application instructions recommend cooling to atmospheric temperatures. Typical uses include industrial stacks furnace doors and external iron work, boiler shells and boiler room equipment operating at temperatures up to 900 deg. F. and numerous other places where heat, corrosion and temperature changes are present.

Presenting FAIRCOSEAL BRONZE VALVES

To meet the increasing demand for valves that will withstand tension, vibration and torsional strains in non-ferrous piping aboard ships and in industry, Fairbanks presents FAIRCOSEAL VALVES . . . bronze valves with threadless pipe connections for making Silbraz joints.

In place of threaded pipe connections, Faircoseal Bronze Valves have recessed ends which contain pre-inserted rings of Sil-Fos silver brazing alloy. The pipe is cut with plain ends and brazed to the valve by the application of an oxy-acetylene flame.

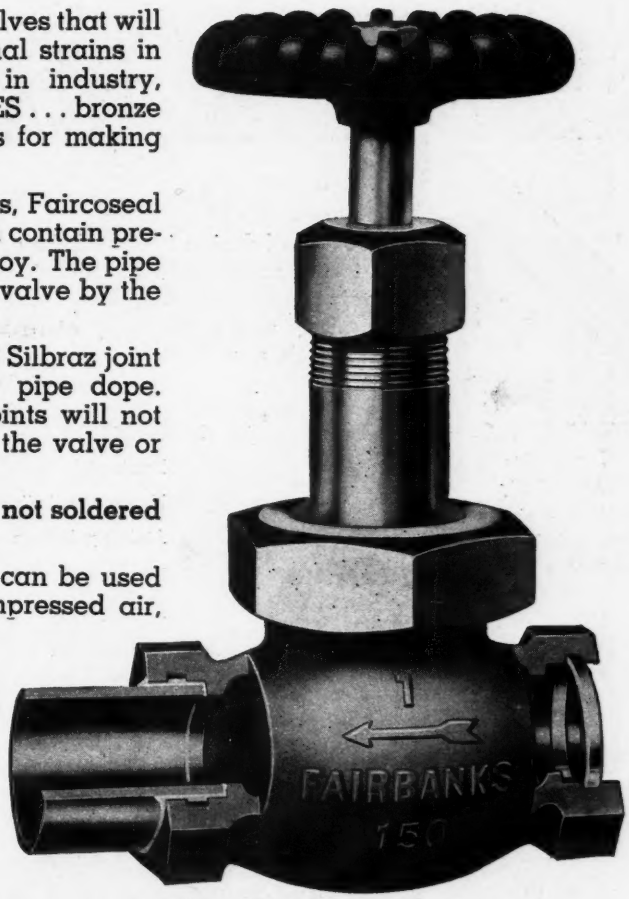
This makes a permanently leak-proof Silbraz joint without the use of wicking, solder or pipe dope. Having high tensile strength, Silbraz joints will not pull apart at any temperature to which the valve or pipe can be safely subjected.

Silbraz joints are **silver brazed joints, not soldered joints.**

Faircoseal Valves and Silbraz joints can be used with steam, oil, hot or cold water, compressed air, acid, Freon, sulphur dioxide, etc.

Silbraz joints have been approved by the U. S. Navy for use aboard naval vessels and have been incorporated in many U. S. Army specifications.

Other features, too numerous to mention here, are explained in the new Faircoseal Bulletin FSV. Write for a copy, or mail the coupon.



Fairbanks *Standard* *and* Renewable **Valves**

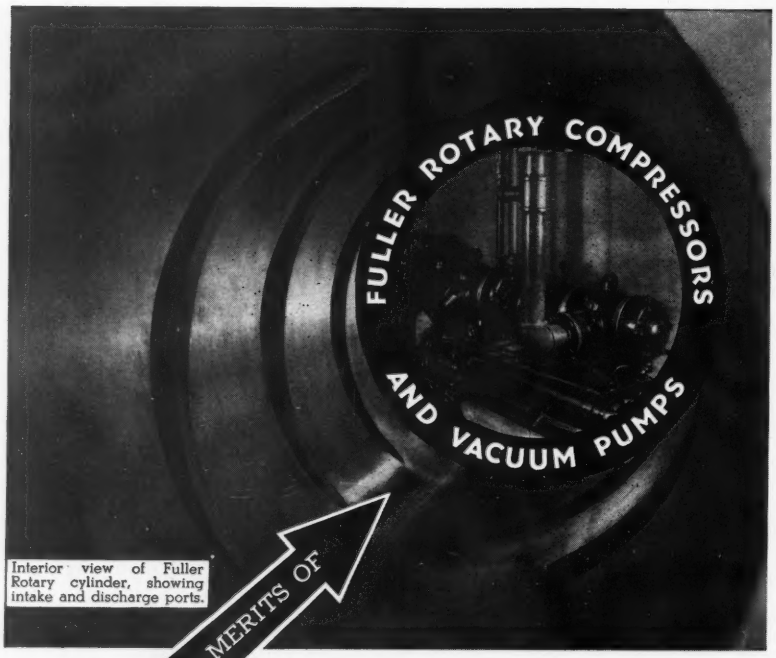
THE FAIRBANKS COMPANY, P.P.E.
399 Lafayette St., New York, N. Y.

Please send Bulletin FSV.

Name.....

Address.....

City..... State.....



Interior view of Fuller Rotary cylinder, showing intake and discharge ports.

LOOK INTO THE MERITS OF

SIMPLICITY of design is one of the contributing factors to the success of these efficient machines . . . a minimum of moving parts: rotor, bearings, blades. They also offer many other worthwhile features, such as:

ADVANTAGES OF—

- Direct drive
- Accessibility
- Low maintenance
- Simple foundations
- Blades automatically compensate for wear
- Maintained capacities for the life of the machine
- Comparatively small floor space with relation to capacity

ELIMINATION OF—

- Bearing take-up
- Unnecessary bulk
- Air-line pulsations
- Large space requirements.
- Leaking valves—grinding of seats
- Multiplicity of parts requiring frequent attention, adjustment and replacement

Fuller Rotaries are built for capacities to 1800 C. F. M. actual free-air delivery, pressures to 125-lb. gauge. Vacuum pumps—for vacuums to 29.90-in. referred to 30-in. barometer.

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA
Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

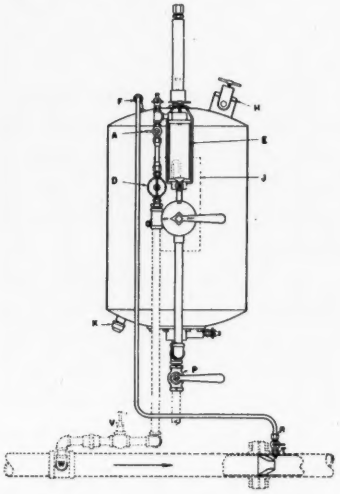
C-61

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

Chemical Solution Feeder

AUTOMATIC proportioning of chemical solution to water treated is accomplished by the Wilson Chemical Solution Feeder designated as Type SP-FW-41 developed Wilson Chemical Feeder, Inc., 110 Washington St., Buffalo, N. Y.

This flow-proportioning device operates in conjunction with pressure differentials caused either by an orifice plate, flow nozzle or venturi tube and is suitable for feeding any alkaline solution, such as phosphates, sodium sulphate, sanosite and calgon. Inasmuch as the feeder depends upon the flow of water through the line, this water must be under a positive pressure from 5 to 100 psi, but the proportioning is not affected by the changes in pressure.



In operation the chemical solution is introduced into a storage tank which is provided with a collapsible diaphragm at the bottom. Introduced at H the chemical solution is discharged at F by the inflation of the diaphragm in the tank. Clear water from point W travels through a three way valve to a metering valve which is used to determine the maximum amount of chemical solution fed over a period of time. From the meter the water is delivered to the bottom side of the diaphragm which is thus inflated and displaces the chemical solution inside the tank.

When the diaphragm inflates to the point where it fills about two thirds of the tank, the indicator in the solution level gage starts to rise, thus giving warning to the operator that it is time to recharge the storage container. Feed adjustment is maintained by means of the metering valve D.

Substitutes for Tin-Base Babbitts

TWO NEW lead-base bearing metals, known as Pyramid and Defender, have been developed by the Magnolia Metal Co., 120 Bayway, Elizabeth, N. J., as substitutes for tin-base babbitts which are now difficult to secure.

The metal is said to be well suited to applications where bearings must withstand heavy sustained pressures, as in marine reciprocating engines, water turbines, paper mill calendar stacks and rolling mill machinery.

Don't Let RUST Strangle Your Turbines!

RUST is a deadly enemy of production that attacks without warning. But it need not catch *you* napping. Drain and refill your turbines now with new, proved, service-tested Shell Turbo Oil . . . the turbine oil that meets all 3 vital requirements of modern turbine lubrication:
RUST PREVENTION
SUPERIOR OXIDATION STABILITY
MINIMUM FOAMING TENDENCY
You're taking a chance if your turbine oil does less. Why not call in Shell today?
SHELL

***Keep your turbines on the job with* RUST-PREVENTIVE**

SHELL TURBO OIL

NOW I CAN'T FORGET

to note the water level

Put a PYREX Broad Red Line Gauge Glass in any boiler room, and the water level of your boilers becomes the center of attention. The transparent broad red line fused directly to the wall of the gauge glass is a far better reminder to the engineer than a string around his finger.

The resistance of PYREX brand Gauge Glasses to the corrosive action of steam insures a longer life of high level visibility. Their machine drawn accuracy, their ability to withstand maximum working pressures, and their remarkable resistance to thermal shock make that life a more useful and economical one.

PYREX Broad Red Line, PYREX Red Line, PYREX High Pressure and Corning Standard Gauge Glasses, for every requirement, are stocked by leading mill and steam supply dealers.

Left, a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Looking Ahead . . .

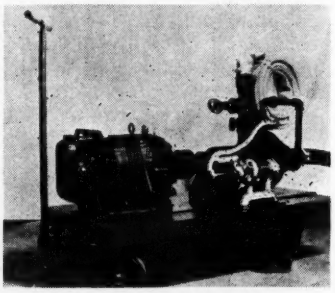
In the power field, perhaps more than in other basic industrial fields, the continuous betterments in machinery and methods compel men to look ahead with broader vision and greater determination than ever before.

Reading the advertising messages that appear in POWER PLANT ENGINEERING will keep you informed on new trends and opportunities. Month after month, these advertisements describe what's new in generating, transmitting power. They will help you and your plant join the onward march of the power plant industry.

Portable Pumping Unit

FAIRBANKS-MORSE Co., 600 S. Michigan Av., Chicago, Ill., has developed a portable pumping unit which may be adapted to a variety of service, municipal and otherwise.

The pump is primed by means of a hand-operated bracket-type pump mounted on the truck platform with its suction connected to the top of the volute through a ¾-in. pipe line equipped with a shut-off valve. The sludge is picked

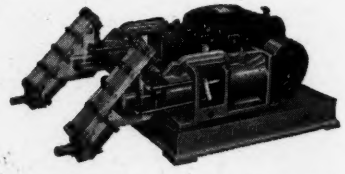


up through a length of 2½-in. wire-lined rubber suction hose and discharged through a length of 2½-in. collapsible cotton fabric hose. The discharge hose is fitted with a gate valve to control the head under high suction lift conditions and to seal the discharge of the pump during priming operations.

This unit can be used with other F-M pumps as well as with the sludge pump. On construction projects, at any place where temporary drainage is necessary, and for any number of other tasks where a portable pump is required this unit is said to be ideal.

Plastic Step-Valve Pump

AN IMPROVED model plastics pump in which the step-valve and inlet and discharge connections are made entirely from transparent plastics is announced by Milton Roy Pumps, 1300 E. Mermaid Ave., Philadelphia, Pa. This pump is for handling alum solutions, hypochlorites, weak acids, mineral and animal oils and many other liquids, the Plexiglas valve being unaffected by most inorganic solutions and by alkalis and oxidizing acids only in high concentrations.



The pump is of typical step-valve design, with double-ball ground glass checks and adjustable stroke for accurate control of volume from one quart per hour up to maximum capacity. Duplex models will handle up to 100 g.p.h., Simplex models up to 50 g.p.h., against pressures as high as 150 psi.

Single-piece cover plates for this valve are removable without disturbing connections, and it is said that this valve is non-clogging, self-cleaning and eliminates air-binding. The transparency of the plastics material makes it possible to watch the pump function and to detect discoloration or dirt particles in the liquid as it passes through the valve.

ANY SHAPE...ANY SIZE

PIPING ASSEMBLIES for meeting the most complex and highly specialized pressure and temperature requirements of Central Stations, Industrial and Process Plants are fabricated in the KELLOGG shops.

Accurately prefabricated, thoroughly tested, they are shipped ready to connect, saving time and money on the job.

You will find the M. W. Kellogg Co. organized to care for the design, fabrication and installation of power and process piping, providing experienced supervision and unified responsibility for the entire job.

KELLOGG

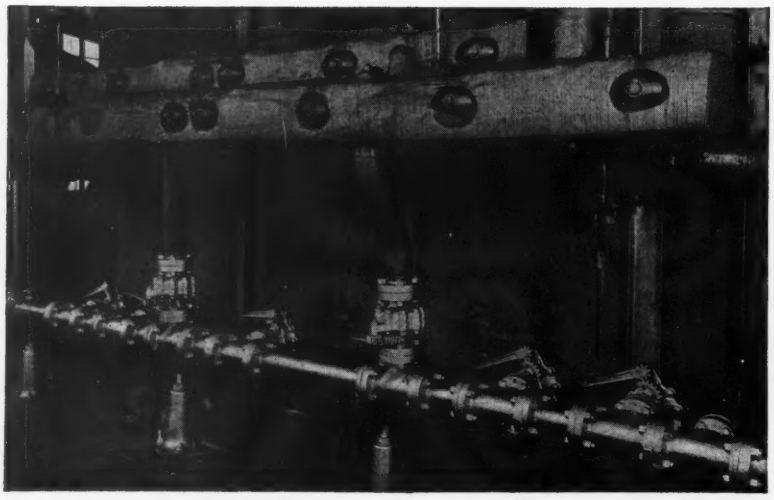
THE M. W. KELLOGG COMPANY

JERSEY CITY, N. J. • 225 BROADWAY, N. Y.

Representatives:

LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization, Thermal and Catalytic Polymerization Units JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.



...in 70 degrees

QUICK, EASY, DEPENDABLE OPERATION

This completely distinctive and unique design has a drop-tight seal which assures leak-proof closure; and the disc has a rotating, self-grinding action on the seat at each movement, which *maintains* tightness indefinitely.

Enthusiastic users report that Everlasting Valves flow fluids faster, give better service, and last longer than other designs on process lines, emergency shut-offs, equipment outlets, boiler blow-off and similar services.

The many important and exclusive advantages of this design are described in bulletin which will be sent on request.

TYPICAL SERVICES WHERE EVERLASTING VALVES EXCEL . . .

Outlets of storage and measuring tanks

Throttles of hammers and hoists

Presses for plastics

Washers for laundries, cleaners and dyers

Spray lines to rolls

Blow-offs of condensers, economizers, vulcanizers, purifiers, compressed air tanks

Suitable for acids, alkalies, caustics, cellulose, coal tar, emulsions, syrups, and other liquids; also gases and vapors

Built in sizes from ¼-in. to 6-in., in cast iron, bronze and cast steel, and with a range of sizes for 250-lb., 350-lb., and 600-lb. pressures. Furnished with straight lever as shown in view of valve, or with rack and pinion as shown in photograph of installation.

EVERLASTING VALVE COMPANY

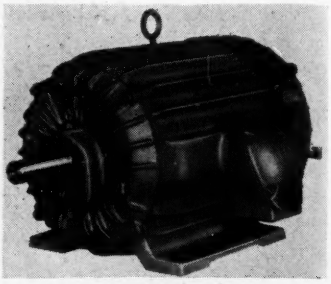
49 FISK STREET JERSEY CITY, N. J.

Everlasting Valves

for everlasting protection

New Enclosed Motor

COWL-COOLED is the name given to the newest fan cooled motor, developed by the Crocker-Wheeler Electric Mfg. Co., Ampere, N. J., and of ultra modern design especially well adapted for use in dusty locations and for applications where the conventional type of totally enclosed motor has previously been recommended.



Because the ventilating air is blown over the external ribs, which run the length of the frame, and is not forced through internal passages, trouble-free operation is assured, even in atmospheres containing excess amounts of destructive fumes, abrasive dust, oil or dirt.

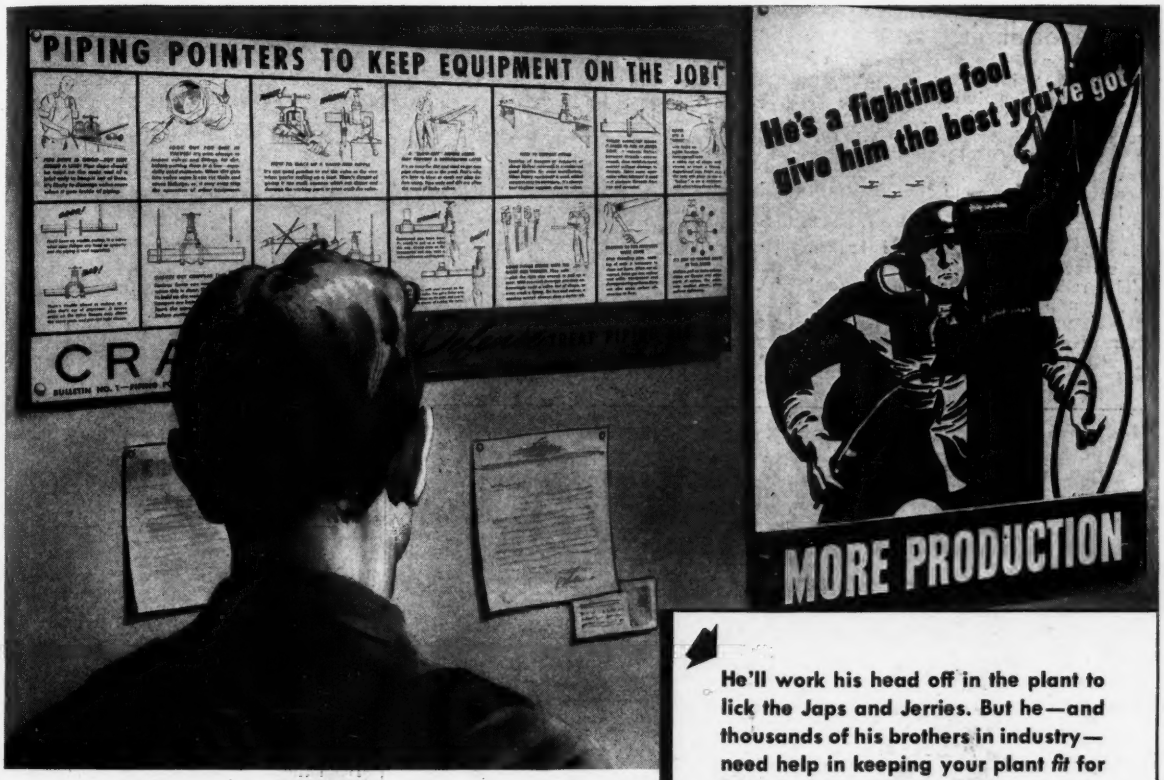
These motors are built to meet severe operating conditions and are now available in standard N.E.M.A. frame sizes up to 20 hp., either ball or sleeve bearing equipped. The sleeve bearing construction is said to be of especial interest to manufacturers and users of precision tools where delicate balance and freedom from vibration are of paramount importance.

Self-Alining Idlers for Conveyor Belts

CHAIN BELT Co., Milwaukee, Wis., announces a new self-alining idler for flat conveyor belts, both return and carrying, which will help to keep the belt central on its supporting idlers.

The operation of this idler is said to be sensitive and instantaneous. If the conveyor belt runs to one side it has a tendency to swivel the idler in a horizontal plane and if this is not sufficient to cause the idler to swing enough to force the belt to throw back immediately, the belt will continue traveling to one side until it contacts the counterweighted end disc, which is slightly larger in diameter than the idler roll. Contact with the counterweight tends to rotate it, but since it is a counterweight it resists this tendency to rotate and produces a counterforce on the idler. This causes the idler to swivel rapidly, throwing the idler more out of line which then immediately forces the belt to swing back the other way.

No side guide rolls to impose unnecessary wear on the belt edge are used, and where excessive misalinement of a conveyor belt exists, caused by stretch or weave in the belt, uneven loading of material on the belt, or shifting of the conveyor frame, the self-alining idlers spaced at intervals between the stationary idlers will automatically bring the belt back to the central position, and avoid the possibility of serious injury to the conveyor belt.



He'll work his head off in the plant to lick the Japs and Jerries. But he—and thousands of his brothers in industry—need help in keeping your plant *fit* for today's triple-shift production job. To provide that help—for him and for YOU—Crane Co., many months ago—established a vital new service for American industry . . . the Crane "Piping Pointers" shop bulletins.

Helpful Hints for Promise-Beaters

KNOWING HOW to choose the right valve for a particular service may make all the difference between smooth-flowing production and a costly interruption. "Piping Pointers" give practical hints on valve selection—hints that prevent many piping troubles—*keep equipment on the job!*

WRENCHES CAN BE DEADLY enemies of production if wrongly used. Because piping equipment must *stay* on the job today—because replacements waste time—waste critical metals—these Crane shop bulletins are showing maintenance crews in thousands of plants how to care for valves.

TRAINING NEW MEN for piping maintenance—helping veterans to *"brush up"* on modern methods—is one of the jobs Crane "Piping Pointers" are doing. Subjects range from how to open and close valves to how to prevent water hammer—all adding up to better piping, more production!

★ OFFERED FREE AS AN AID TO VICTORY—"Piping Pointers" are available *free*—on request—from your local Crane Representative—or by writing to the address given here.

CRANE

CRANE CO., GENERAL OFFICES, 836 SOUTH MICHIGAN AVENUE, CHICAGO

VALVES • FITTINGS • PIPE • PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

Glass Floodlight

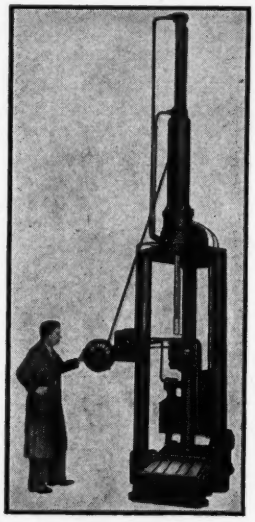
COMBINING the high reflectivity of silvered glass with shock resistance, a new glass floodlight has been announced by the Lighting Division of the General Electric Co., Schenectady, N. Y. Designed to eliminate vital materials needed for War Effort, the new unit's reflector is coated by electrolytically deposited metal which together with an over-all backing of porcelain enamel keeps the glass from shattering even if it is broken by a severe blow.

The reflector is joined to a metal socket housing which is sealed with a heat-resistant gasket which acts as a preventative against the entrance of water, making the floodlight corrosion-proof. Glass and gasket fit solidly against the reflector, further assuring protection against dust or dirt. This floodlight, said to be from 10 to 30 per cent more efficient than units it replaces, utilizes 300 or 500-watt lamps.

Honing Machine

INTERNAL cylindrical surfaces with bores up to 24 in. in diameter and with any stroke from 20 in. up to 72 in. can be honed on the new Hi-Speed honing and lapping machine manufactured by the Automotive Maintenance Machinery Co., North Chicago, Ill.

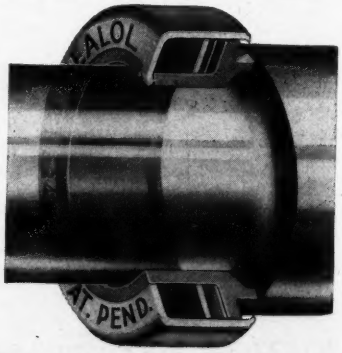
The honing machine is designed to permit rapid honing of a wide range of work, straight line lapping or co-directional honing. It is said to remove high spots, out of roundness and taper, and produce a round straight bore with an ideal surface. Design provides ample space for large cylinders to be placed on standard base. Variations in stroke or height under the spindle nose are said to be such that this machine can be adapted to many types of honing work.



All controls are located at the front of the machine at the operator's station. Any stroke setting, withdrawal of hone from the cylinder, short stroking at any point, changes in speed of reciprocation or rotation of the spindle, can be had from the front of the machine regardless of stroke capacity. The honing machines are made in 4 sizes, with strokes up to 72 in.

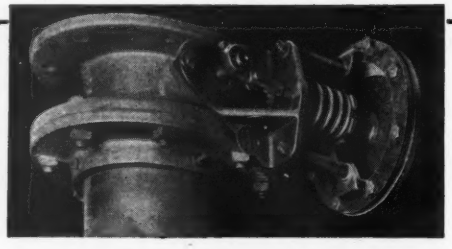
Balanced Pressure Seal

THE Stevenson Engineering Corp., Providence, R. I., have recently announced a new type balanced pressure seal. A mechanical seal with only five parts to the assembly, it is for rotating shafts with the initial sealing contact between the sealing ring and the hardened lapped face achieved by the fluid pressure itself acting on two opposing surfaces of different areas. The force exerted by a fluid under pressure on a given surface is in direct proportion to



the area of that surface. The amount of overbalance has been standardized for most applications and can be engineered for particular conditions. The full fluid pressure acts against the synthetic rubber packing, assuring a complete seal between the sealing ring and the retainer cup.

A Simple Automatic Vent for Steam Condenser Lines



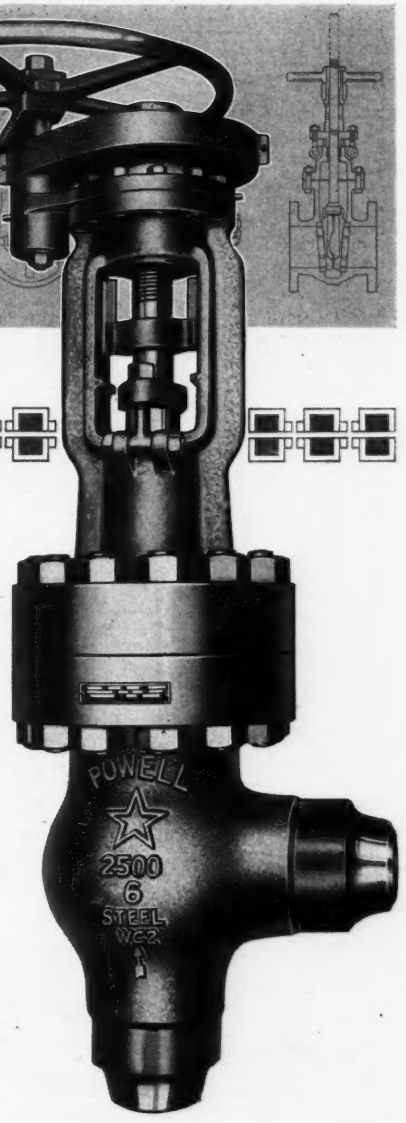
15 lb. R-S Butterfly Valve. Air diaphragm motor operated with 15 p.s.i. air. Entirely automatic control. Many other applications. Easily installed for the positive control and wedge-tight shut-off of air, gas, oil, flue dust, steam, water and semi-solids.

R-S Streamlined BUTTERFLY VALVES

- Wedge-tight shut-off because precision machined and the angle of closing of the vane against the valve body.
- Light weight and compact construction effect substantial savings in installation costs. Trouble-free operation with zero maintenance.
- Self-cleaning due to streamlined vanes and straight, accurately-machined body bores. Flow is straight—no turbulence.
- Smooth and rapid action in opening and closing. Manually operated by hand lever, hand wheel, chain lever and chain wheel. Extended shaft provided for inaccessible locations.
- Special R-S pressure iron castings for resistance against heat, abrasion and corrosion.
- Sizes to 84-inches and pressures to 300 lbs. Write for Catalog No. 10-B.

R-S PRODUCTS CORPORATION
4535 Germantown Avenue, Philadelphia, Pa.

Design



Design is what makes one airplane fly higher and faster than another. It makes one gun shoot farther and straighter than another. One tank hit harder than another.

Design is what makes Powell Valves perform better and last longer in the industrial tasks to which they are assigned. It is exemplified in the vast assortment of special valves built to do special jobs that make up the Powell Line. It is carried on by a corps of highly trained experts working with the most modern technical equipment available. It will continue to represent the part that Powell has played and is still to play in the forward march of Industry.

The Wm. Powell Company
Cincinnati, Ohio

Fig. 25033-WE
This valve—a 6-inch, Class 2500 pound Cast Steel Angle Valve with welding ends—is another example of Powell *design* and rugged construction for peak performance in high temperature-pressure service. It is regularly furnished with Semi-cone Seat and Disc; also with Anti-friction Bearing Yoke and Spur Gears for quicker, smoother, easier operation. Can be equipped with bevel gears, and motor operators.
For special throttling service, the same valve as above, except with Piston-guided Disc (Fig. 25028-WE) is available.

POWELL VALVES

FLOW METERS
BY COCHRANE
COCHRANE Thirties Type FLOW METERS
2-PEN FLOW RECORDERS
desired to record two flow measure-
me chart. The 2-pen Cochrane elec-
own above accomplishes this. It is
lete Cochrane flow meter receivers
double depth case.
a at a premium, or where it is desired
flow records on the same chart for
this construction achieves the result
n and with no loss of accessibility. It
st as in the Cochrane single pen flow
nechanisms can operate in the swung-
onnection between the rear receiving
pen arm must necessarily be detach-
ously arranged with a self-aligning
measurements are involved, the
sufficient guidance by observing the
of it) of the two pens. However, this
e note which pen is which. For cases
where continual reference must be made to this relation-
ship of the two records, Cochrane offers the ratio indi-
cating pointer shown above. The clearly visible red target
moves to right or left from the center point on the scale
and thus shows at a glance whether there is an excess or
deficiency of one of the quantities with respect to the
other. The pointer movement moreover is two and one-
half times greater than the difference between the two
recording pens and is thus much more readily noted.
This construction can be supplied with or without the
auxiliary indicating ratio pointer. Even without the pointer
its price offers no advantage over two separate recording
meters since it consists of virtually the same equipment
as would be involved in the separate meters plus a more
expensive case construction.
Integrating feature can be furnished on both mechanisms
but reading of rear mechanism integrator requires open-
ing case and swinging front mechanism forward.
[3010-20]
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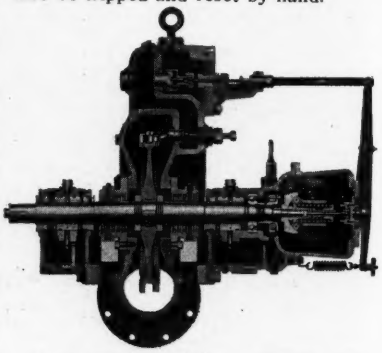
Velocity-Stage Turbines

VELOCITY-STAGE turbines designed to meet modern conditions of steam pressure and temperature, and used for driving auxiliaries, such as pumps and fans, have been announced by the DeLaval Steam Turbine Co., Trenton, N. J.

The turbine has a centrifugal speed governor and an independent emergency tripping device consisting of an electrically loaded pivoted ring which at a predetermined speed releases the emergency shut-off valve, which has a stainless steel stem. The valve can also be tripped and reset by hand.



The speed-regulating governor consists of fly weights pivoted on rockers, and is mounted on the turbine shaft or on a vertical shaft driven through a worm and worm wheel. The governing action is transmitted to the regulating valve through a ball thrust bearing and a lever mounted on a needle bearing. The speed can be changed while the turbine is running by a spring adjustment. The regulating valve is of the balanced seating type and is actuated through a stainless steel stem packed with asbestos rings. The emergency closing and governor regulating valves are preceded by an accessible and removable steam strainer, consisting of a heavy monel screen.

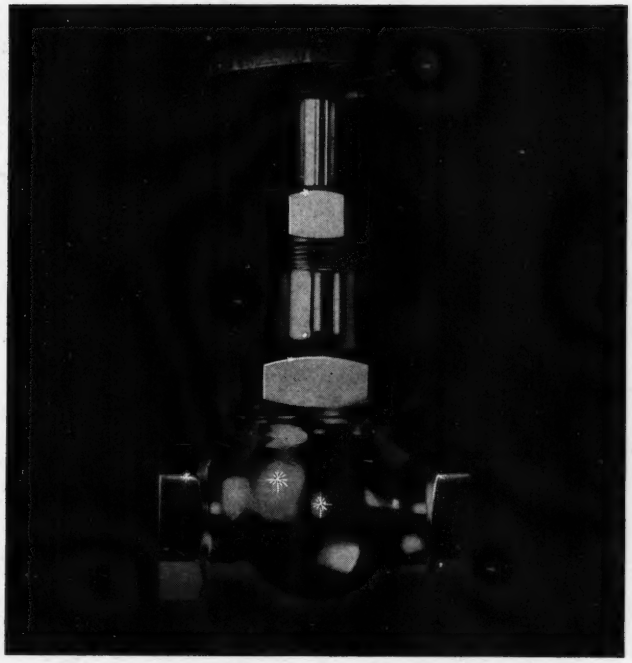
General Utility Sealing Compound

DUXSEAL, a non-hardening adhesive sealing and caulking compound suitable for a wide range of uses, is offered by Johns-Manville, 22 East 40th Street, New York, N. Y. Used like putty, just as it comes from the package, the compound, it is stated, sticks readily to any clean surface without slumping, flowing, or hardening in service, and is insoluble in water, unaffected by ordinary gases and condensates, and will not hurt the hands.

Duxseal was originally developed by Johns-Manville for the electric power and telephone companies to seal openings in ducts carrying electrical conductors, but now is available for general utility service.

The material is black in color and weighs 100 lb. per cu. ft. It is furnished in 1-lb. and 5-lb. pugs, in cartons of 60 and 12 pugs.

Three additional sealing compounds, similar in appearance and general characteristics, but differing in consistency and certain individual properties, have also been added. Pakseal is designed for service where greater stiffness and rigidity are required; Transolseal, for service requiring resistance to refined oils; and Nodrseal, for use in food storage and refrigerators.



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VALVES FOR
POWER PLANTS
★

LOYALTY IS NOT TAGGED WITH THE PRICE OF BRASS

These are the UNITED STATES.

Of course we differ among ourselves. But the world has learned, again, that these are family matters—marks of energy that, upon attack, crystallize to dynamic unity.

Men who battled the devil with words from the pulpit now fight him with machine guns from the ranks. Fingers that were trained for gossamer express their loyalty on the assembly lines of huge bombers that will blast America's enemies from security.

And it is no less indication of the spirit today that, as forge and press thunder their answer to the call to war, men in industry cease to demand that priority deliver *anything* for peace that tools can fashion into arms. In that same spirit, too, men no longer clamor that vitals such as nickel, chromium, and brass be delivered for civilian use.

Certainly, substitutes for products of proved economy work hardship and add to the cost of industry. And that may be particularly true when applied to valves.

But, Americans already prove that they don't tag their loyalty with the price of Brass!

READING-PRATT & CADY

MANUFACTURERS OF R *AND* PRC CO. *VALVES AND FITTINGS*

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MORE POWER

The new Roto Tube Cleaners give you power to produce more power because they enable you to descale your tubular equipment hours faster than was ever possible with old type cleaners. Coupled with the increased cleaning power of the new Roto motor is the time and labor-saving Roto operating air valve. This valve enables one man to operate the cleaner entirely by himself, and eliminates the delays caused by signalling a helper to turn the air on and off between every tube cleaned. Now, more than ever, you need the fast, effective results which Roto can give you.

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RUBBER & GLASS DIVISION LIVINGSTON, NEW JERSEY

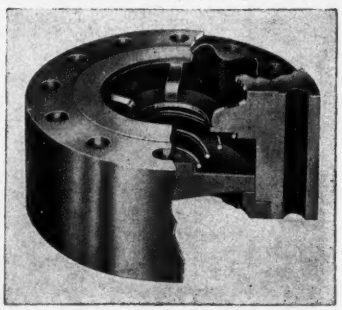
CO_2 Indicator

FYRITE CO_2 indicator, recently announced by the Bacharach Industrial Instrument Co., Pittsburgh, Pa., is said to be highly accurate and simple and convenient to operate. The aspirator bulb fills the Fyrite gas chamber with the flue gas to be analyzed and the sampling hose is then detached which automatically seals the Fyrite and makes it ready for analysis. When mixing the flue gas sample with the absorbing fluid the Fyrite is turned upside down, then back to its upright position. The suction created due to the complete absorption of the CO_2 pulls the absorbing fluid up an amount equal to the CO_2 absorbed.

The fluid level in the graduated tube shows the percentage of the CO_2 in the gas flue sample. The absorbing fluid is said to last for several hundred readings before replacement is necessary, and should not freeze under winter temperatures normally experienced.

Flanged Silent Check Valves

THE WILLIAMS Gauge Co., 2056 Pennsylvania Ave., Pittsburgh, Pa., announces an improved line of check valves which are furnished in a wide variety of metals and sizes. Designated as the Williams-Hager Flanged Silent Check Valves, they are manufactured of bronze, cast iron, steel, stainless and monel metal for pressures varying from 150 to 2500 lb. Sizes range from 1 to 20 in.



Simple, compact and rugged in design, the check valves have two parts subject to wear—the valve disc and seat. Both are easily removable and renewable, and the valve is said to be reseated without special tools. The spring ring is now built as an integral part of the body.

These valves are designed for use in waterworks, oil refineries, chemical works, air conditioning systems, hydraulic services, boiler feed, water supply and other non-return flowlines, and may be used in all pump lines handling water, oil, gas, acids, alkalines and fluids.

On time again . . . over Tokyo and Berlin

NOT in a frenzied joy in destruction, or an unholy lust for blood; but in the solemn and angry conviction that by the cleansing of two areas of the world's surface, and all they stand for and all the thoughts that breed there, we can build a better world; in this spirit must our nation's will, and the sinews of our industrial strength, and the striking power of our fighting arm be directed to our task. Together we must labor toward this goal . . . *for from those bomb bays fall the seeds of peace!*

In industrial warfare, water is a weapon. If there are any problems concerning its proper treatment in your plant, Graver engineers, with years of experience behind them, are at your disposal—without obligation.

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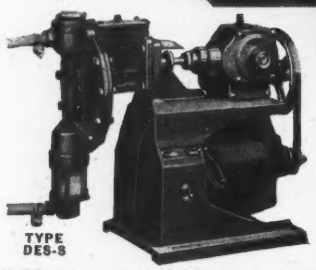
For BOILER CHEMICAL FEED, CORROSION CONTROL, AUTOMATIC PROPORTIONING, PH CONTROL, ETC.

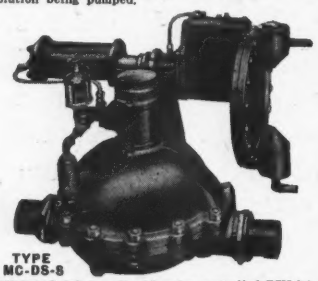
Use "PULSAFEEDER"

Features Complete ISOLATION of Operating Parts From Chemical Being Pumped



TYPE DES-S

TYPE DES is an electric motor driven, manually adjustable feeder. Either plastics or metallic diaphragm head can be furnished. The type of check valves is determined by the characteristics of the solution being pumped.



TYPE MC-DS-S

TYPE MC-DS is a liquid meter controlled PULSAFEEDER which may be driven by either air or water power. The meter is used for the purpose of pacing the PULSAFEEDER. However, only a minute amount of power is taken from the meter and therefore it does not impair accuracy in any way.

The Wilson "PULSAFEEDER" is of the Pulsating Tube type, gives positive displacement feed with no pressure differentials and assures complete *isolation* of the chemical solution being pumped from operating parts.

This "PULSAFEEDER" feature eliminates such troublesome points as packing gland leakage, diaphragm breakage, and assures an absolutely accurate feed.

Other advantages of "PULSAFEEDER" include: Transparent plastic valves and blocks for visible operation—Chemicals handled are not contaminated by oil, grease or other lubricants—Piston has low effective area and is easy on power—Micrometer feed stroke adjustable in operation assures precise, flexible control.

"PULSAFEEDER" comes in capacities from 0 to 360 G.P.H., and pressures up to 1000 lb. per sq. in. May be driven by electric or water motor, or auxiliary plant apparatus. Find out how they can give your plant better, lower cost chemical feeding.

WRITE FOR BULLETIN

WILSON CHEMICAL FEEDERS, INC.
202 Clinton St., Buffalo, N. Y.

Six Ways in Which Advertising Can Help Government and People

(1) Speed governmental accomplishment in the drive for victory . . . (2) Expedite conversion of industry to wartime production . . . (3) Ease the shock of war on civilian population and national economy . . . (4) Divert demand from scarce articles to those more plentiful . . . (5) Explain business to the public . . . (6) Condition markets for postwar developments.—G. D. Crain, Jr., Publisher of "Industrial Marketing"

Low Priority Hard-Facing Rods

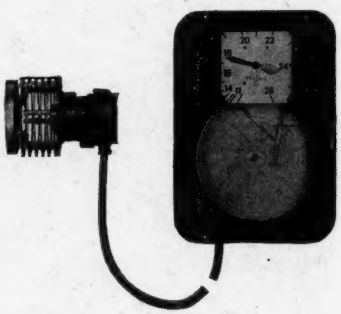
FOR COMPANIES unable to furnish high priority ratings, the Stoody Co. has developed two new hard-facing alloys, Stoodite K and Stoody Self-Hardening K, which are distributed by Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y.

Stoodite K, a cast hard-facing rod of molybdenum, tungsten, manganese, silicon, carbon, and iron, is supplied for oxyacetylene application and in coated form for d.c. electric application. It is available in five rod sizes, 1/8, 5/32, 1/4, 5/16 and 3/8 in., and in rod lengths of 14 in. Deposits of Stoodite K average 54-58 on the Rockwell C scale, depending on the type of parent metal and the method of application, and forms smooth, dense deposits free from porosity and shrinkage cracks. Deposits will withstand considerable pressure and impact if properly supported, and are said to resist abrasive wear.

Stoody Self-Hardening K principally of molybdenum, manganese, silicon, carbon, vanadium, and iron is made in the form of tubes with the mixed alloys on the inside. This rod is supplied bare for oxyacetylene application and bare and coated for d.c. electric application. It is available in three rod sizes: 1/8, 5/32 and 1/4 in. Electric rods are 14 in. in length and acetylene rods 28 in.

Radiation Pyrometer

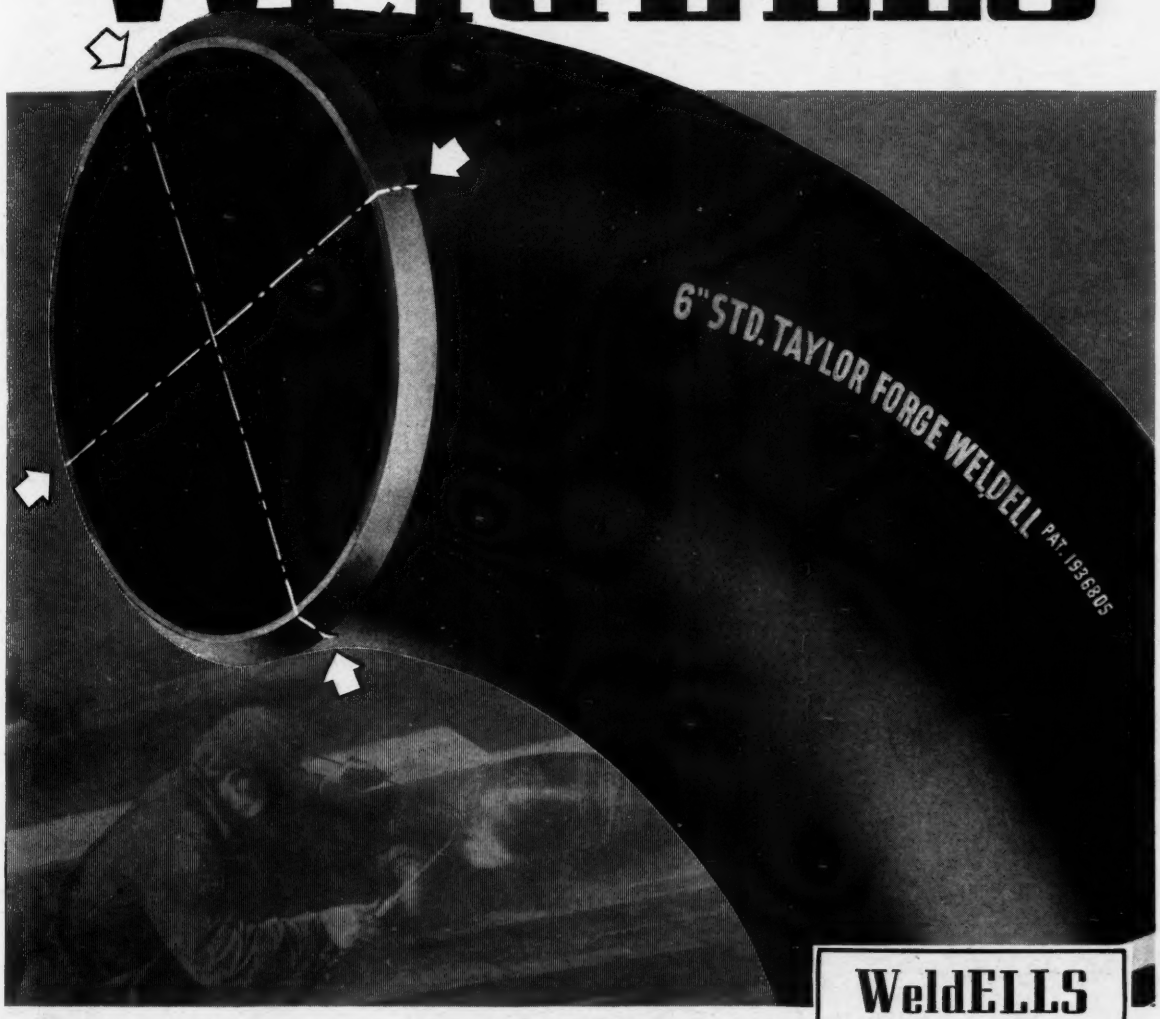
PYROVAC, radiation pyrometer, has been developed by the Bristol Co., Waterbury, Conn. This new instrument is designed for recording, indicating, or automatically controlling temperatures in furnaces and kilns above 900 deg. F. The temperature-sensitive unit or radiation head is mounted on the outside of the furnace out of the hot zone where it picks up heat rays emitted from the object under measurement, thus registering its surface temperature.



The radiation pyrometer is intended for use in measuring and automatically controlling high temperatures out of the range of the thermocouple; temperatures for which rare-metal thermocouples are used; surface temperatures, such as roof, wall, duct, lining, or retort temperatures and the temperature of the work itself rather than furnace or kiln temperature surrounding the work; and where object is moving, is inaccessible, or where there are space limitations.

For protection in case of air raids, Kil-Mag, a specially prepared powder made for extinguishing fires and incendiary bombs, has been announced by the Ray Engineering Co., 806 N. Broad St., Philadelphia, Pa. The powder is available in two size tubes.

WeldELLS



THEY SPEAK HIS LANGUAGE

—*these precision quarter-marks*

Just ask the man who welds them, if you question the importance of these precision quarter-marks that are found only on WeldELLS and other Taylor Forge Welding Fittings.

He'll tell you how much time and trouble these reference points save in figuring center lines, angles and offsets; how much easier they make it to keep piping lined up in the proper plane. Fact is, this exclusive feature would be reason enough to insist on WeldELLS even if they didn't have the many other improving features listed opposite.

But quarter-marks are only one extra value of the fittings that have *everything* . . . for the man who specifies, welds, or pays the bill!

WeldELLS
have *everything*—

No other fittings for pipe welding combine these features which in addition to quarter-markings include:

▶ **Seamless**—Greater strength and uniformity.

▶ **Tangents**—Keep weld away from zone of highest stress—simplify lining up.

▶ **Selective reinforcement**—provides uniform strength.

▶ **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.

▶ **Wall thickness never less than specification minimum**—assures full strength and long life.

▶ **Machine tool beveled ends**—provide best welding surface and accurate bevel and land.

▶ **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

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NEW BULLETIN SHOWS HOW TO USE LEAD-BASE BEARING METALS

Complete information on how to effectively substitute lead-base babbitts for tin-base bearing metals is contained in this new Magnolia manual which is packed with helpful bearing data.

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MAGNOLIA BEARING METALS

GET MORE POWER *QUICKLY*

with ENCO *Streamlined* BAFFLES

THE advantages of Enco Patented Streamlined Cross Flow Baffles have been so definitely established that all water tube boilers, whether new or old, should be equipped with them as a first step to better steam plant efficiency.

Every Enco Baffle Wall is designed to obtain the best results from the heating surface available in each boiler. Constructed of specially developed materials and installed gas tight by skilled mechanics.

Streamlined to avoid eddy currents and eliminate dead gas pockets that collect soot and fly ash. They save live steam because soot blowers work less often and more effectively.

Write for Bulletin B-40. It tells why Enco Baffle Walls improve the performance of new and old boilers to deliver more steam at lower cost.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK, N.Y.

Heavy Duty Thermostat

A NEW HIGH capacity thermostat for use wherever 2-wire (Series 40) or 3-wire (Series 60) line voltage control is required has been developed by the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

This thermostat, the TA42, is an electrical version of the horizontal design which was pioneered in pneumatic control. This principle affords maximum air circulation about the element and insures against possible harmful effects of electrical contact heat. The movement of the extremely sensitive, vapor-filled bellows is transmitted to the QS611 Con-Tac-Tor Snapswitch. Because this switch is non-magnetic in operation, it is not affected by vibration nor by "contact bounce". It is fully enclosed to protect it from dirt, dust and grime and prolong the life of special silver contacts.

Features include removable adjustment knob which also locks the cover and prevents any unauthorized tampering; bakelite base that is both an electrical and a thermal insulator; and dead front which eliminates shocks and short circuits since, even with the cover removed, no electrically live parts are available from the front.

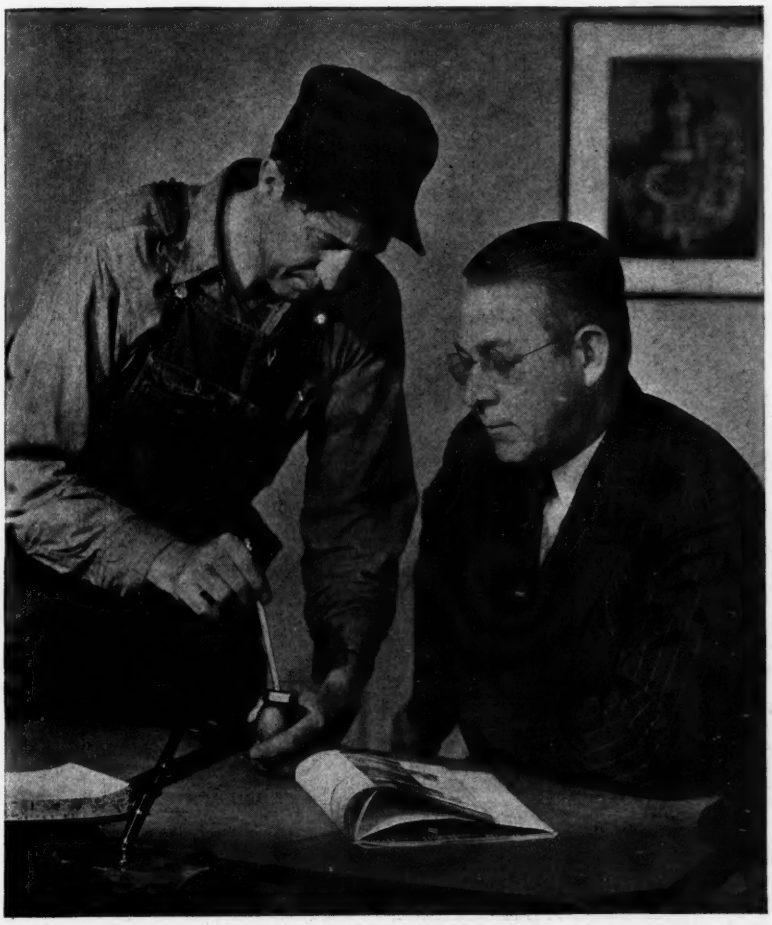
The thermostat is readily applicable to motor-driven unit heaters, water circulators, coal blowers, motorized valves and motorized dampers. It can also be used with a magnetic starter on large or polyphase motors, and for usage in air conditioning and cooling installation.

pH Tester

pH TESTS for degree of acidity or alkalinity of solutions can be made by a simple technique using the new Cargille Buffer Set No. 1 with Hydrion Wide-Range pH Test Paper, manufactured by R. P. Cargille, 118 Liberty St., New York, N. Y.

Solutions of known pH, made by dissolving the tablets in this set, are applied to the test paper to bring out on the paper the color for any half unit from pH 3 to pH 11. The colors are used for reference to judge the pH of the sample being tested; comparisons made with these reference colors are more accurate than those made with color charts. Readings can be made to one-half pH unit. Designed for control tests in the plant by unskilled workmen; also for quick, preliminary tests in laboratories where more elaborate pH apparatus is available.

Fusol, a combination sludge solvent and carbon remover has been announced by the Marfax Chemical Co., 33 W. 42 St., New York City. The product is poured directly into the oil tank, and it is said to make the oil free flowing and prevent the formation of carbon in preheater tubes and burners, and also prevent sludge deposits in strainers.



"HERE'S WHY WE PREFER KENNEDYS, CHIEF"

"Look at those wide passageways and that clean machine work, Chief. Take that one little detail of the milled stem-head recess in the disc holder and the rounded bottom surface of the stem head in this bronze globe valve. It helps me start the valve open and close it tight. And notice that fine-grained metal. I'll bet this valve will never leak."

"Every Kennedy Valve has good points like these. That's why we should use nothing but Kennedys for that new war plant."

Because of the uniformly good design, and excellence of workmanship and materials in Kennedy Valves, they are being installed in many plants, ships, housing projects and other war efforts.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK

KENNEDY *valves... pipe fittings... fire hydrants*

NO RUBBER BELTS in the...

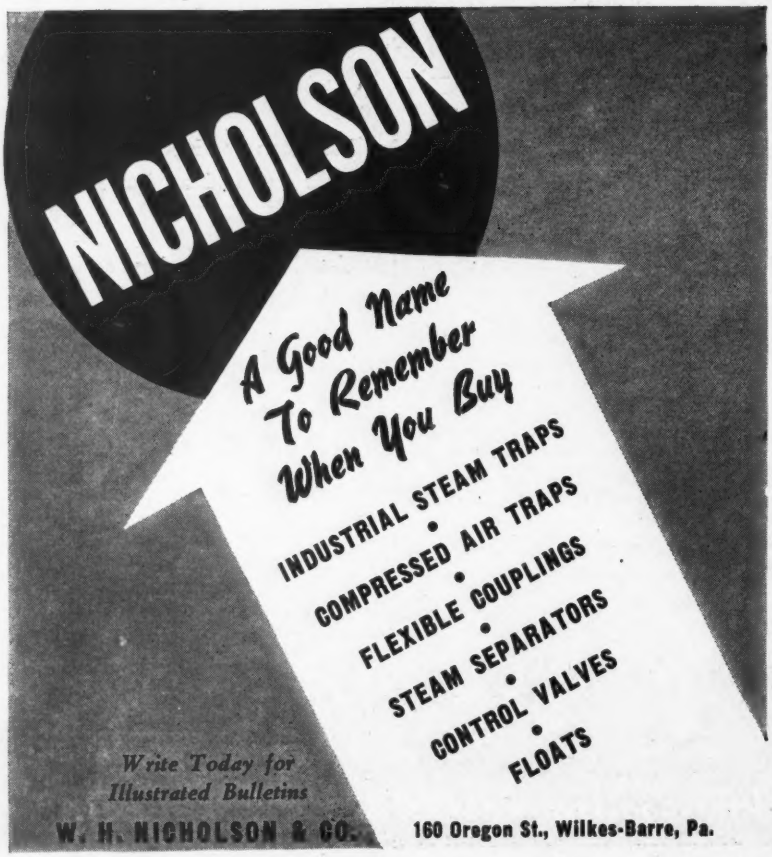
"BEAUMONT VIBRO"
AUTOMATIC WEIGHING SCALE

PATENT APPLIED FOR

For accurately weighing coal and similar materials from 1 to 60 tons per hour. Simplified design eliminates all rubber belts, pulleys and motors. Totally enclosed and dustproof. By-pass chute prevents flooding and will operate instantaneously.

Write us today for complete details

BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.
BULK MATERIAL HANDLING EQUIPMENT



Furnace Door

A NEW type of furnace access, inspection, and clean-out door for boilers, incinerators, etc., has been announced by the Plibrico Jointless Firebrick Co., 1800 Kingsbury St., Chicago, Ill.

A feature of this door is the Lock-Tite handle which is said to lock the door so tightly that all infiltration of excess air around the door is eliminated. The handle operates on a cam and lever principle so that the further the handle is depressed, the tighter the door is forced against the frame. The elimination of excess air around the door contributes to combustion efficiency.

The door is lined with Plicast L-W-I light weight insulating refractory material which reduces the weight of the door, protects the metal from the heat, and decreases the radiation of heat into the boiler room.

The furnace door should be of interest to any plant which contemplates the installation of new boilers or other furnaces, the rebuilding of existing boiler settings, or the installation of new fuel-burning equipment.

MANUFACTURERS' NEWS

In a letter announcing the award of the Navy E to the De Laval Steam Turbine Co., Trenton, N. J., Secretary of the Navy Knox congratulates the workers and management upon their significant contribution in industrial production and its output of geared turbine propelling equipment and pumps; since the beginning of rearmament the company activity has been increased to the utmost, the total of orders now running into many millions of horsepower.

Employes of The Foxboro Co. who have completed 25 yr. or more in its service were honored recently at a celebration, held in Foxboro, Mass. A jeweled service pin of gold was presented to each of the 50 men and women honored.

Almost another 50 employes have service records which are within a few months of the quarter-century mark; and plans for similar celebrations will be held annually.

The Swartwout Co., Cleveland, Ohio has organized The Swartwout Pacific Co., with offices at 560 Seventh St., San Francisco and complete facilities for manufacturing industrial roof ventilators. A substantial increase of industrial expansion on the coast during the last 18 mo. to meet war requirements dictated the decision to locate a plant convenient to this territory.

Moore Machinery Co., 1699 Van Ness Ave., San Francisco, Cal., has recently been franchised by Whiting Corp. of Harvey, Ill., to represent them in California, Arizona, and Nevada. The Moore organization will handle the application and sale of Whiting overhead traveling cranes and hoists, rotary shears and stamping trimmers, and such Whiting transportation shop equipment as drop pit tables, locomotive and car hoists, locomotive spotters, car washers, cinder conveyors, and turn-tables.

It's not packing— it's* RE-*packing that's really expensive . . . that's why it pays in dollars and cents to use the best packing money can buy. J-M Sea Rings are that kind of packing.

They're custom-made to fit specific operating conditions. Entirely automatic, they seal on the work stroke, release on the return, thus reducing friction and wear on both packing and rod. During the past 25 years many engineers have accepted Sea Rings as the standard packing for reciprocating rods and plungers operating against steam, water, air, brine, oil, gasoline and many other fluids and chemicals.

For details on J-M Sea Rings and the complete line of J-M Packings and Gaskets, write Johns-Manville, 22 E. 40th St., New York, N.Y.

JM

Johns-Manville PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

Sorry, but it now takes an A-1-J PRIORITY or better . . .

. . . TO BRING YOU THE WORLD'S FINEST PUMP VALVE PERFORMANCE

These improved COMBINATION Valves are non-tilting. They close quickly, enable the pump to handle its theoretical capacity without racing and wasting costly steam. Their extra durable construction (seat, stud and spring are Phosphor Bronze) means fewer pump shutdowns for overhauling, real savings in maintenance.

LET US SEND YOU OUR NEWEST BULLETIN ON COMBINATION PUMP AND SILENT CHECK VALVES.

COMBINATION PUMP VALVE CO.
846 WIOTA STREET, PHILADELPHIA, PA.

Ways In Which Wartime Advertising Helps You

SOMEONE said recently that "advertising is a convenient and effective channel for getting useful information from where it is to where it is needed".

Using POWER PLANT ENGINEERING as such a channel, scores of advertisers are now passing along practical wartime information on how and where to apply power equipment to increase plant capacity, to facilitate conversion to war production, to guard against shutdowns, to reduce maintenance expense.

Now more than ever before it will pay you to read the advertisements in POWER PLANT ENGINEERING. They can help you keep posted on new and better operating methods, aid you and your plant to contribute more fully to the nation's all-out "battle of production".

Ergolyte Mfg. Co. Doubles Size of Philadelphia Plant

THE ERGOLYTE MFG. CO. recently announced the opening of a new plant at 3627-29-31 N. Lawrence Street, Philadelphia, Pa. The new factory is more than twice the size of the firm's previous Philadelphia plant. According to John H. Read, company President, the move was necessary to keep up with Ergolyte's round-the-clock production schedules. Mr. Read indicated that a large quantity of new and specialized manufacturing and testing equipment developed especially to speed production of the company's welding machines has been installed.

J. F. Pritchard & Co. Expands

J. F. PRITCHARD & CO., Kansas City, Mo., has recently greatly enlarged its division of chemical design, engineering and construction to meet growing requirements of the new Petro-Chemical industry. Dr. W. W. Deschner, formerly in charge of the Department of Chemical Engineering at the University of Kansas, is the new head of this division. The emphasis placed on Petro-Chemistry is directly due to the rapid developments in this field, according to officials of the Pritchard Co. This organization has long been active in the petroleum, power and natural gas fields in connection with the design and installation of compressor stations, dehydration plants, cycling and extraction plants, steam, Diesel and gas power plants, cooling towers and similar equipment.

Special Duty Pump Units

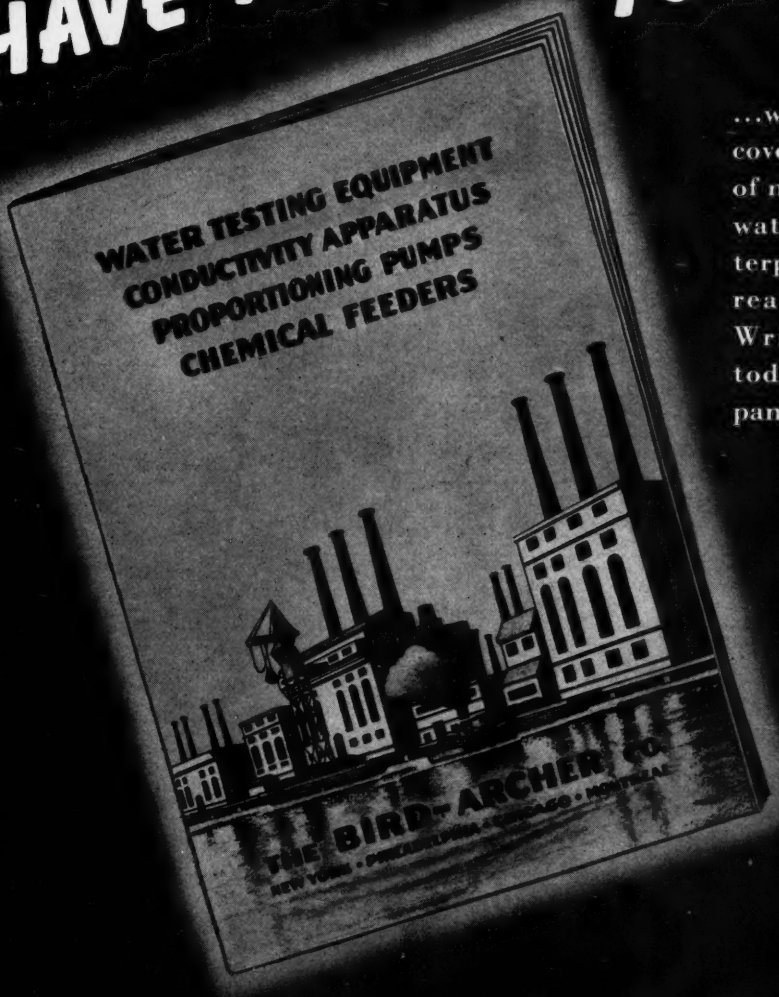
DANGERS of incendiary bombs has brought to home owners, factory managers and municipal officials alike the importance of ever-ready pumping equipment in case of fire. Recently developed fire pumping units by Fairbanks-Morse Co., 600 S. Michigan Ave., Chicago, now afford small plants and towns adequate fire protection at a moderate cost well within their means and needs.

One of these new Fairbanks-Morse Fire Pumping Units, approved by the Underwriters' Laboratories was recently installed in Delavan, Wisconsin. It is composed of a 4-in. Figure 5813 F-M Fire Pump driven by a Ford-Mercury Engine. The Mercury Engine drive, turning at 2500 r.p.m. is of sufficient speed to be direct connected, eliminating the expense of gear drive necessitated when a slow speed engine is connected to a high speed pump.

New Navy Plant for Pennsylvania

PLANS for immediate construction of a $14,000,000 plant in western Pennsylvania, to produce propulsion equipment for the United States Navy, were disclosed recently with the appointment of L. D. Ridgon, of the Westinghouse Elec. & Mfg. Co., as manager of the plant. F. D. Newbury, vice-president in charge of Westinghouse Emergency Products Division, announced that the company has been selected to build and operate the plant for the Bureau of Ships, Navy Department, and the

HAVE YOU SENT FOR YOUR COPY ?



...with a special section covering the procedure of making all necessary water analyses, their interpretations, and the reagents required... Write for your copy today — on your company letterhead, please.

THE BIRD-ARCHER CO.

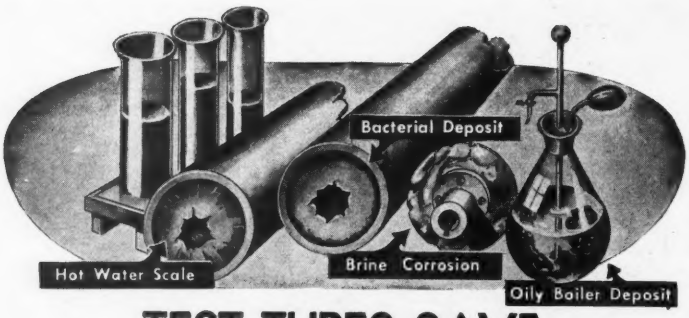
Scientific Water Conditioning
SINCE 1885

Philadelphia, Pa.
4337 North American St.

Chicago, Ill.
2030 North Natchez Ave.

New York, N. Y.
100 Madison Ave.

7-BA-2



TEST TUBES SAVE WATER TUBES

Haering products and Haering service are directly stepping up war production. They control corrosion in boilers, condensers and engine cooling systems and all water equipment used in gasoline production, munitions, tanks and many other war products.

Our ability to read water and our many glucosate correctives are doing active service in war industries.

Send for booklets on scale and corrosion control, cooling waters, proportioning problems.

Write for sample containers and data forms to give us a complete picture of your problems.

D. W. HAERING & CO., INC.
"WE READ WATER"
GENERAL OFFICES: 205 West Wacker Drive
CHICAGO, ILLINOIS

Save Time—Look First In The "Where-To-Buy" Directory

Suppose you need gaskets, gauge glasses, pump governors, steam traps or other power service equipment in a hurry.

Do as hundreds of engineers and plant executives do—turn first to the handy "Where-To-Buy" Directory published in this issue.

You'll find there comprehensive up-to-date product listings of well-known concerns which advertise regularly in POWER PLANT ENGINEERING. They probably have branches or sales agents in your locality.

Stone and Webster Engineering Corp. has been selected as general contractor for the project which will include a 1-story manufacturing building and a separate heating plant.

The western Pennsylvania site was selected for the new Navy plant after careful study had been made of more than a dozen other sites within a 60-mi. radius of Pittsburgh. Factors influencing the selection included the availability of high-quality labor, railroad and highway facilities, electric power, water and gas. In addition, the Westinghouse East Pittsburgh works will be near enough to supply critical parts to aid the plant's production in case some of the major machine-tools cannot be delivered to the plant in time.

Floating Emergency Power Plants

FLOATING power generating plants for emergency use in case of breakdown of existing power facilities, or, to supplement such facilities to meet unprecedented needs for electric power, are now realities according to Gordon Lefebvre, vice president and general manager of The Cooper-Bessemer Corp.

"It is possible", Lefebvre, said, "to easily provide floating power plants, assigned to strategic areas, that could be quickly towed to affected districts and supply electric power until the land facilities were restored. Floating power plants are not still in the 'dream' stage. A very successfull floating Diesel power plant, consisting of ten 100 hp. Diesel engines set five in a row on each side of a line shaft which runs down the center of the plant is now in use on the Mississippi River.

"Each engine is equipped with a twin-disc clutch and on the outboard side of the clutch shaft is an 8 groove pulley 15 in. in diam. All 10 of these Diesels are connected to a single shaft that drives a generator at the far end. Any engine in the group can be disconnected from the shaft when desired. In this particular case, the power furnished was used for dredging but it could just as easily be converted to vital power needs in case of disaster to a land power plant."

Gilmer National Power-Recovery Plan

GOVERNMENT and industrial authorities have come to realize that power is a basic weapon in the Battle of Production and that many industrial plants are now close to the safe limits of their power supply. This condition throughout the country is a danger to production and is forcing every plant manager to consider means not only of cutting down waste of power but more economical methods of producing it.

To aid in this movement, John S. Krauss, president of the L. H. Gilmer Co., Philadelphia, Pa., recently announced the Gilmer National Power-Recovery Plan which is designed to stimulate the reduction of power losses in industrial plants by the adoption of minor betterments and organized systematic maintenance.

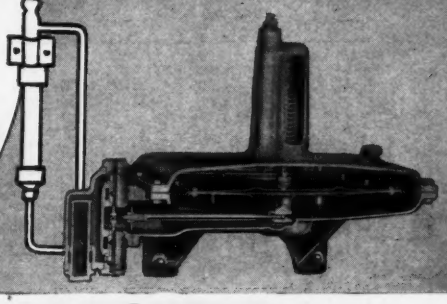
To put this plan into operation the Gilmer company has prepared a series of blank forms called Power-Recovery Estimators which are designed to be distributed to the key men in the plants. The estimators are simple and practical

Helping to CREATE CAPACITY for GREATER PRODUCTION by Eliminating WASTE

★ CORRECT FUEL FEED
You Save COAL, OIL OR GAS

★ PROPER AIR SUPPLY
YOU BURN FUEL *Economically*

★ CONSTANT OVER-FIRE DRAFT
You Prevent UNDUE STACK LOSS



FURNACE DRAFT CONTROLLER
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.

CASH STANDARD

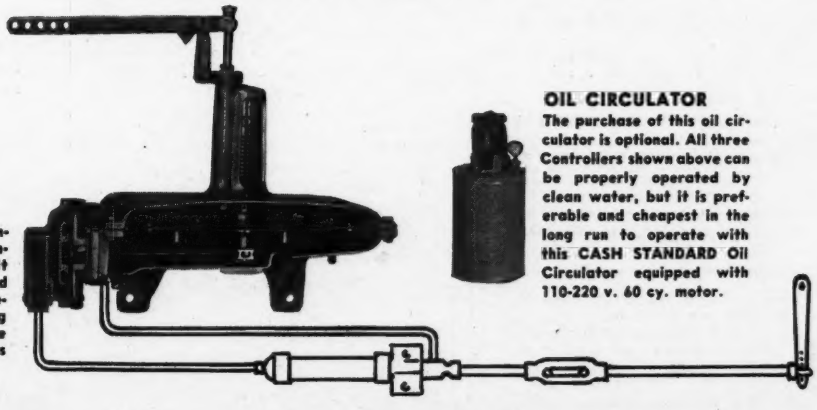
AUTOMATIC COMBUSTION CONTROL SYSTEMS

BOOST YOUR BOILER OUTPUT

• Keeping fuel consumption low is one effective conservation job being done by CASH STANDARD Automatic Combustion Control Systems. Accomplishing this and yet boosting boiler output adds another to the important CASH STANDARD results. The fuel requirements for a given load are reduced because the rate of fuel feed is adjusted exactly to the need — you eliminate fuel waste.

CASH STANDARD units, which make up the systems, are available in a number of variations and can be applied in all plants from the very largest to those as small as 75 boiler horsepower. Bulletin 300 gives full details on application and operation — tells about maintenance savings and why you can hold steam pressure to within very close limits.

FUEL FEED CONTROLLER
This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.



AIR FLOW CONTROLLER
This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

OIL CIRCULATOR
The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator equipped with 110-220 v. 60 cy. motor.

A. W. CASH COMPANY
DECATUR, ILLINOIS

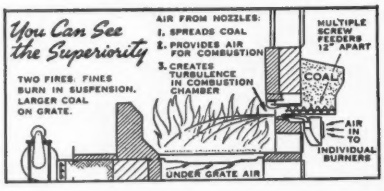
CASH STANDARD
CONTROLS . . VALVES

FYR-FEEDER

MULTIPLE SPREADER STOKERS

OIL BURNER Users—Vital Industrial Plants -get QUICK DELIVERY!

FUEL Shortage, Steam Shortage, Man-power Shortage problems find a quick, efficient solution when you install the multiple FYR-FEEDER Spreader Stoker! Burns local coals—excellent results with cheapest grades—more steam, less work, no clinkers. Our engineers will be glad to help you make application to qualify for *IMMEDIATE DELIVERY*. Write to AMERICAN COAL BURNER CO., ENGINEERS, 22-18 East Erie St., Chicago, Ill.


You Can See the Superiority
AIR FROM NOZZLES:
1. SPREADS COAL
2. PROVIDES AIR FOR COMBUSTION
3. CREATES TURBULENCE IN COMBUSTION CHAMBER
MULTIPLE SCREW FEEDERS 12" APART
TWO FIRES. FINES BURN IN SUSPENSION. LARGER COAL ON GRATE.
COAL
AIR IN TO INDIVIDUAL BURNERS
UNDER GRATE AIR

MULTIPLE BURNER SPREADERS ARE ADVANTAGEOUS AND NECESSARY.
Each FYR-FEEDER has 2, or 4, or more burner spreaders giving dependability and convenience in cleaning grates, impossible to secure with a single spreader.

TERRITORIES FOR SALES ENGINEERS

Some territories are open for experienced sales engineers familiar with steam plant boilers and furnaces. Information on request. Please furnish record of your experience and references.

AMERICAN COAL BURNER COMPANY,
Engineers
22-18 East Erie St., Chicago, Ill.

☐ YES, I want to know what the FYR-FEEDER can do in our plant.
☐ Please mail descriptive literature.
☐ I am interested in selling FYR-FEEDERS.

Name .....
Company .....
Address .....

forms for the men to follow in listing the locations of the power losses that can be most easily converted into use, the correction which is necessary, the time needed to make the correction, whether the material needed to make the correction is available, and the approximate cost of the correction. The items are to be listed as urgent, important, or less important.

Instructions are given for use of each estimator and typical ways to save are listed. The subjects covered are: electricity, steam, mechanical power, water, compressed air, refrigeration, boiler room, prime movers, and everywhere. These estimators, properly filled out, become reports to be handed to the proper executive of the company and constitute a power recovery survey of his plant. The Gilmer company is undertaking to distribute without charge full instructions and blanks to the responsible executives of all industrial plants in the country.

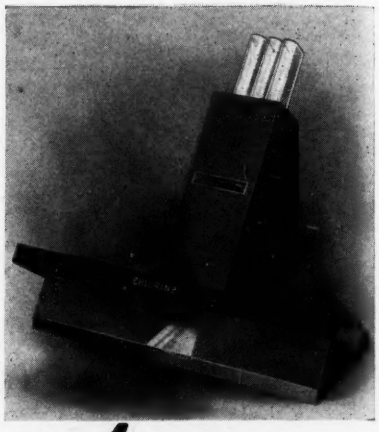
MANUFACTURERS' PERSONALS

Addison F. Vars, president of the Sterling Engine Co., announced that Hans Bohuslav has joined the company as vice-president in charge of engineering. Before coming to the Sterling Engine Co., Mr. Bohuslav was associated with the Enterprise Engineering Co. of San Francisco, as chief engineer and later vice-president in charge of engineering. He is known as an authority on Diesel and gas engines, and directed the development of the current Enterprise engines.

J. A. Danner, engaged in the Chicago area as industrial sales promoter for Standard Oil Co. of Indiana's Chicago division, retired recently under the company's retirement plan. Mr. Danner began his service with the Standard Oil Co. 26½ yr. ago after 14 yr. with Illinois Steel and 4 yr. with International Harvester. Harry G. Stiles, assistant promoter of industrial sales, has been promoted to fill Mr. Danner's place. During much of his 20 yr. experience with the company, Mr. Stiles has served as an expert counselor to industrial plants on lubricating problems.

Ralph E. Day, president of the Bridgeport Brass Co. for the past 12 yr., has resigned because of ill health. The board of directors named Herman W. Steinkraus, vice-president and general manager, to the presidency and announced he would continue in his managerial capacity. Mr. Day, president since 1930, will continue on the board. He joined the company in 1928, as general manager after 22 yr. with the American Brass Co., Hastings, N. Y., where he had been plant manager. Mr. Steinkraus was appointed general manager in 1941.

Ellis E. Jensen, Executive Director for Wisconsin of the National Conference of Christians and Jews for the past 3 yrs. has been employed as a research assistant in the industrial relations department of the Allis-Chalmers Mfg. Co., as announced recently by Lee H. Hill, vice-president of the com-



Analyze BOILER WATER *this Easy, Quick Way!*

The new Taylor Water Analyzer is a sturdy outfit especially designed for speedy and accurate determination of the ammonia content and pH of condensate . . . the latter generally acknowledged as one of the most difficult pH determinations. The CO_2 and ammonia content must be known when total solids are determined by conductance measurements, since these dissolved gases may contribute as great a conductivity as that representing the dissolved solids. Now, you may quickly and accurately determine both pH and ammonia content of condensate, as well as silica, total iron, etc., in boiler water, in a few minutes by using the Taylor Water Analyzer!

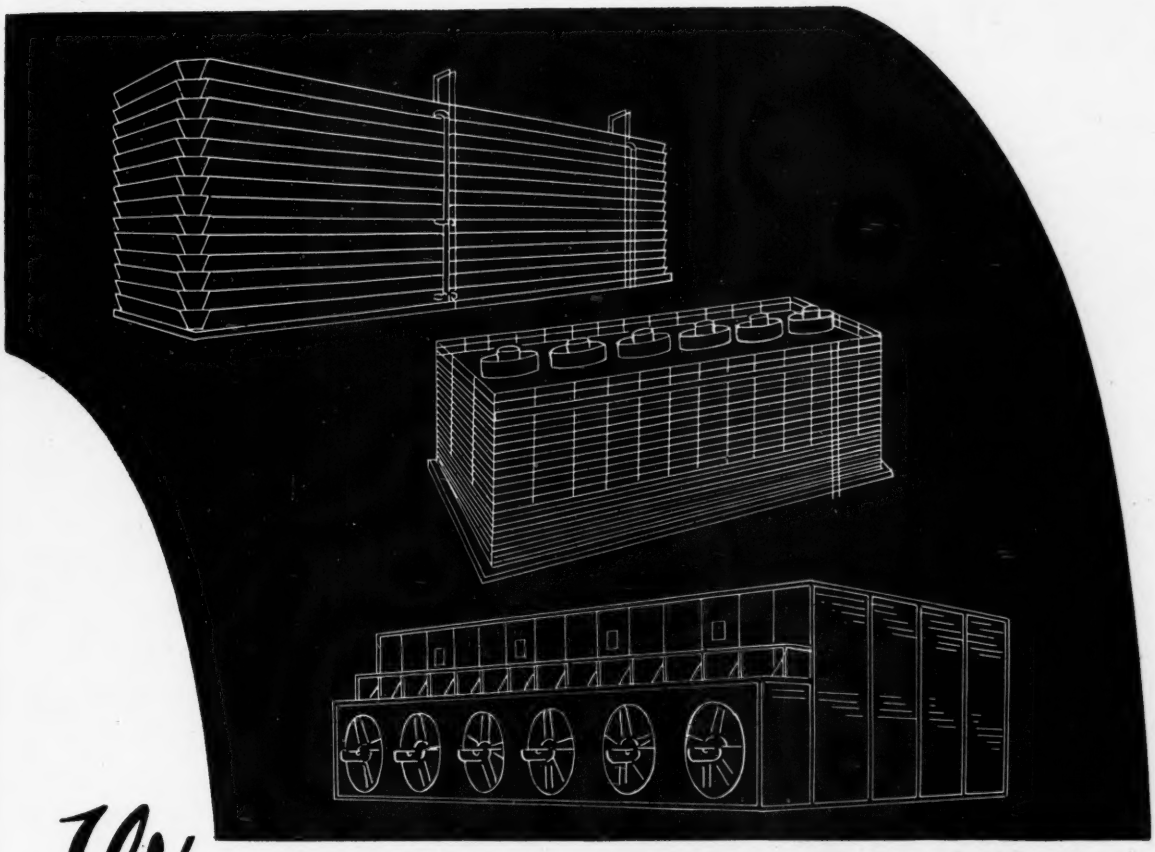
Complete with 1 slide....$18.00
Extra slides, each..... 8.00
F.O.B., Baltimore

All Taylor color standards carry AN UNLIMITED GUARANTEE AGAINST FADING!

Get This Booklet

See your dealer or write direct for booklet "Modern pH and Chlorine Control"—a factual, informative booklet that you will find extremely useful.

W. A. TAYLOR AND CO.
7301 YORK RD. • BALTIMORE, MD.



Whenever you need RELIABILITY ---HERE IT IS!

The cooling tower is a vital link in today's chain of production. It can facilitate or retard all plant processes. Few things can cause less trouble —or *more* trouble. Therefore reliability is essential.

Pritchard towers have always been designed and constructed to meet emergency as well as normal requirements. Very liberal safety factors, great structural strength, proved special features of design are built into each tower. Long time retention of rated thermal efficiency, low annual cost, dependable, reliable service . . . are results of this policy.

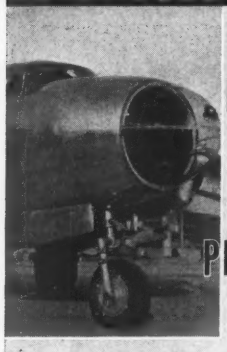
Ask those who own them. Write for Bulletins 42 and 42-A.

J. F. PRITCHARD and COMPANY, Dwight Building, Kansas City, Mo.
Branch Offices: Tulsa, Okla.; Houston, Tex.; Atlanta, Ga.; Chicago, Ill.; Pittsburgh, Pa.; New York City

PRITCHARD

Atmospheric and Mechanical Draft WATER COOLING TOWERS

COCHRANE



The EAGLE'S EYES are PLEXIGLAS

PLEXIGLAS is an acrylic plastic manufactured by Rohm & Haas Co., Bristol, Pa., and used in the nose, observation hatches, gun turrets, etc., in bombers and other aircraft. It is more transparent than glass, and is impervious to the effect of sunlight and extremes of heat, humidity, etc. In its manufacture, one of the essentials is

CLEAN, HOT, DRY STEAM
insured by the use of
Cochrane SEPARATORS

Fig. 118 Cochrane All-Service Separator on process steam line in plant of Rohm & Haas Co.

(Right) Bomber nose of Plexiglas being buffed and polished.

Cochrane Separators insure pure, hot, dry steam because of their scientific design. Purified steam cannot contact the entrainment because steam flow is guided away from drip area. Baffle area extends far outside jet of steam from inlet pipe. Write for Publication 2725.

COCHRANE CORPORATION
3123 N. 17th STREET - PHILADELPHIA, PA.

COCHRANE

pany. Dr. Jensen was an exchange fellow at the University of Berlin in 1931 and 1932, received the degree of Doctor of Philosophy in 1939 from the University of Chicago, has written widely in the field of human relations and has spoken before hundreds of schools and clubs in Wisconsin.

Harry C. Beaver has been elected president of Worthington-Gamon Meter Co. to succeed the late E. T. Fishwick. Mr. Beaver is also president of the Worthington Pump and Machinery Corp. R. R. Anderson, treasurer and manager of Worthington-Gamon Meter Co. has been elected vice-president and director, as well as retaining his office as treasurer.

Walter Geist, president of Allis-Chalmers Mfg. Co. announced the appointment of William C. Johnson as general sales manager. Since 1940 Mr. Johnson has had charge of sales for the crushing and cement division, and has been a member of the Allis-Chalmers organization since 1924.

The Botfield Refractories Co., Philadelphia, announces that George B. Botfield has been appointed assistant vice president of the company. He will be in charge of the Pittsburgh territory, making his headquarters with the Pittsburgh Supply Co.

Gene Ingalls Joins Thomas C. Wilson

APPOINTMENT of Eugene K. Ingalls to the sales department of Thomas C. Wilson, Inc., manufacturer of tube cleaners, Long Island City, N. Y., was recently announced by O. J. Bagnoli, vice-president and general manager of the company. Gene Ingalls is well known to users of tube cleaning equipment in central stations, manufacturers' power plants, refineries and shipping circles throughout the United States and Canada and also has had experience in the export field. He is a graduate of the University of Minnesota, class of 1923, and is a member of the N. A. P. E.

York Announcements

BECAUSE of the increasing volume of War Production contracting with government authority, York Ice Mach. Corp. has enlarged and increased the facilities of its Washington office. This will be designated as the national sales office and will operate as a direct factory branch, located at 215 Investment Building, Washington, D. C. M. S. Lebair, formerly manager of the Philadelphia office, is the new national branch manager.

Last month York also opened a new downtown office in Manhattan. Alfred Christensen, formerly sales manager of the York Brooklyn branch has been named branch manager. The new office, located in the Pershing Square Building at 100 East 42nd St., will replace facilities formerly located in Brooklyn on property which has been sold to the United States Coast Guard.

Bergmann, Link-Belt Chief Engineer

ANNOUNCEMENT was made by Link-Belt Co. recently that Richard F. Bergmann has been appointed chief engineer with office at executive headquart-

AMERICAN CHIMNEY CORPORATION

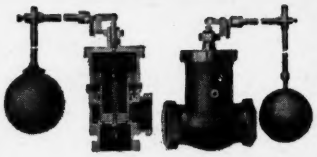
Consult us for:

Radial Brick Chimneys
Common Brick Chimneys
Ornamental Chimneys
Linings for Steel Stacks
Chimney Repairs and Extensions
Installing, Repairing Lightning Rods

AMERICAN CHIMNEY CORPORATION
147 Fourth Ave., New York City

BRANCHES: BOSTON, MASS.
PHILADELPHIA, PA. • PITTSBURGH, PA.
CLEVELAND, O. • DETROIT, MICH.

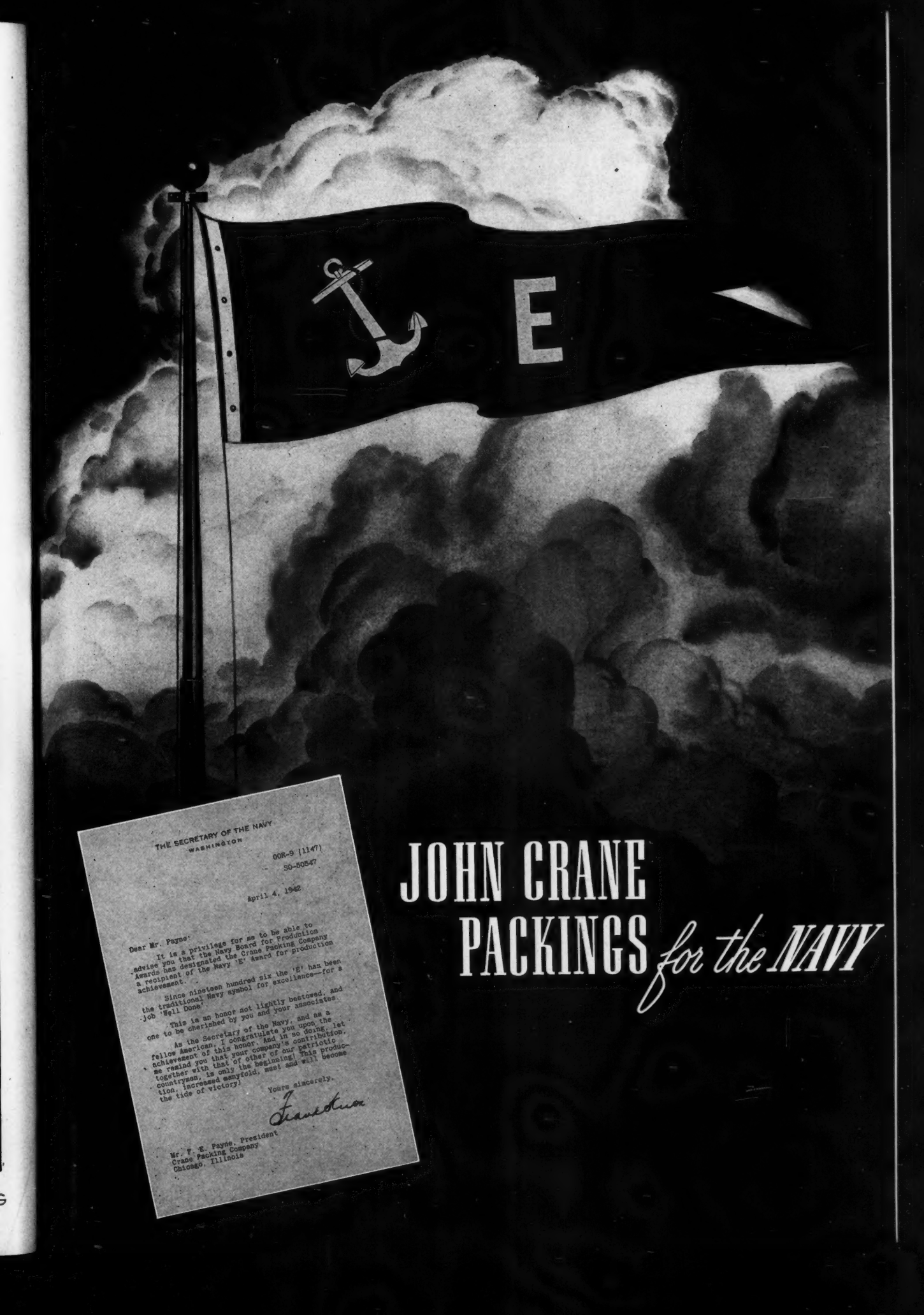
See pages 56 and 57 of our new 96-page catalog for information on these
STANDARD COLD WATER FLOAT VALVES



Furnished in sizes ½" to 2" bronze, screwed ends, these Float Valves are recommended for cold water service where minimum inlet pressure is not less than 10 pounds per square inch.

Valves may be arranged with remote pilot control valve in lieu of integral lid pilot valve as shown; also, to function on differential water levels—that is, to close at desired full-tank level, but not reopen against influent pressure until the tank level lowers to a predetermined depth.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.



THE SECRETARY OF THE NAVY
WASHINGTON

00R-9 (1147)
SO-50547

April 4, 1942

Dear Mr. Payne:

It is a privilege for me to be able to advise you that the Navy Board for Production Awards has designated the Crane Packing Company a recipient of the Navy 'E' Award for production achievement.

Since nineteen hundred six the 'E' has been the traditional Navy symbol for excellence—for a job 'Well Done'.

This is an honor not lightly bestowed, and one to be cherished by you and your associates.

As the Secretary of the Navy, and as a fellow American, I congratulate you upon the achievement of this honor. And in so doing, let me remind you that your company's contribution, together with that of other of our patriotic countrymen, is only the beginning! This production, increased manyfold, must and will become the tide of victory!

Yours sincerely,

Frank Knox

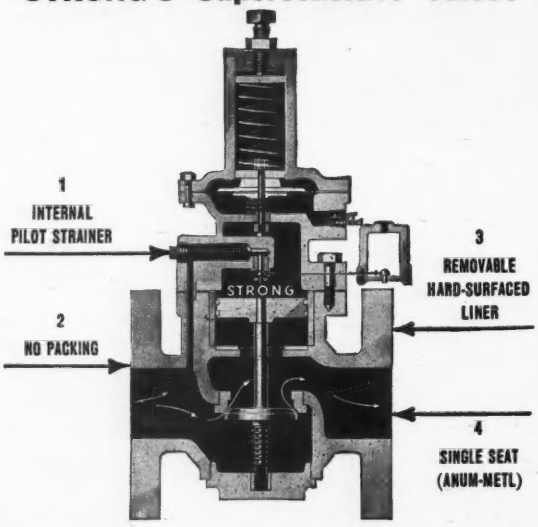
Mr. F. E. Payne, President
Crane Packing Company
Chicago, Illinois

JOHN CRANE PACKINGS *for the NAVY*

PIPEWRENCH PETE SAYS:

NOW—You Can Regulate Pressure to a Gnat's Eyelash!

4 Trouble-Saving Features In STRONG'S Supersensitive Valve!



How STRONG'S Type "C" Valve Works

High (inlet) pressure forces piston down, opening valve and admitting pressure to reduced (outlet) side. When reduced pressure reaches point valve is set to maintain, diaphragm is forced up, closing pilot valve, and shutting off high pressure to piston chamber. As pressure in piston chamber decreases, bottom spring and steam velocity close main valve.

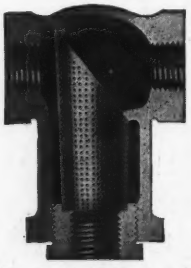
In actual operation, valve automatically adjusts itself to meter the volume of steam, air or gas required to maintain the reduced pressure.

Long, Trouble-Free Life

Because of its simple, sturdy construction, the STRONG Type "C" regulating valve meets the need for accurate, trouble-free pressure regulation.

Write about your pressure reducing problems or for Catalog 154.

QUICK CLEANING STRAINERS



Regular semi-steel, suitable for pressure to 250 lbs. or 400 degrees. Pressure-cleaned by removing bottom plug or opening valve. Install ahead of reducing valves, etc.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

ers in Chicago. Mr. Bergmann had been assistant to the chief engineer from 1933 to 1936, when he resigned to become chief engineer of Rayon Machinery Corp., Cleveland, Ohio. He is a native of Logansport, Ind., was graduated from Rose Polytechnic Institute at Terre Haute, Ind., in 1918, and joined Howe Chain Co., Muskegon, Mich. Following the merger of Howe Chain Co. with Link-Belt he was transferred to Chicago in 1924.

William W. Sayers, chief engineer since 1925, has been appointed consulting engineer. He will continue to deal with patent matters and be available for engineering consultation.

McClave Co. Announces Appointments

THE MCCLAVE CO., Allentown, Pa., recently announced additions to its sales organization staff.

H. T. Warren, formerly of Reynolds Metals Co., Inc., has been appointed manager of sales for the Central New England District Sales Territory, with headquarters at 125 Trumbull St., Hartford, Conn.

D. H. Hull, sales engineer of Memphis, Tenn., has been appointed manager of sales for the Memphis District Sales Territory, with headquarters at 1292 Mississippi Ave., Memphis, Tenn. Mr. Hull's territory includes western Tennessee, eastern Arkansas, northern Mississinpi and northwestern Alabama.

A. W. Fish, formerly associated with the Buick Motor Car Corp., Syracuse, N. Y., has been appointed manager of sales for the Central New York State Sales Territory, with headquarters at 857 Summer Ave., Syracuse, N. Y.

NEWS FROM THE FIELD

Joseph W. Hicks, for many years a well known figure in publicity and public relations work for utilities, industrials and associations, recently opened an office, as public relations and industrial relations counsel, at Suite 3103, 333 North Michigan Ave., Chicago, Ill.

Utility Executive Honored

SYLVESTER B. WAY, graduate of the Drexel Institute of Technology, 1895, was the recipient of the honorary degree of Doctor of Science at the Institute's commencement exercises held June 13, in Philadelphia. Mr. Way is president of the Wisconsin Electric Power Co., Chairman of the Board of the Milwaukee Electric Railway and Transport Co., President and Director of the Wisconsin Gas and Electric Co., Wisconsin Michigan Power Co., Badger Auto Service Co., the Milwaukee Light, Heat and Traction Co.

Technological Institute Dedicated at N. U.

America's newest outpost of technological science was dedicated June 15 and 16 at Northwestern University, when the University's new Technical Institute, the gift of Walter P. Murphy, was officially opened. The gift of Mr. Murphy amounted to $6,735,000 and over a year was used in construction on the buildings, which contain over 10 acres of floor space.

Approximately $1,000,000 alone was spent on new scientific equipment for teaching and research. Among the unusual installations are a 5,000,000 lb. hydraulic press, which can crush a concrete column 3½ ft. dia.; a 1,000,000 lb. machine for testing large beams and columns; a soundproof room said to be the quietest room in the world; a cold room for full scale research at temperatures down to minus 70 deg. F.; an artificial river for testing boat models and wave action; and equipment for producing rain and lightning for the testing of insulation under abnormal voltage.

Vital war research is already being carried on by the Institute. A Naval Radio Operator's Training School is now in progress, and by September will have 1,000 men enrolled.

J. Robert Fortune

J. ROBERT FORTUNE, senior partner in the firm of J. Robert Fortune & Son and charter member of the Engineering Society of Detroit, died on May 22, after a brief illness. Mr. Fortune was born in Detroit and began his career as a draftsman for the Murphy Iron Works, which later became the Riley Stoker Co.

In his later years Mr. Fortune was active in sales engineering, being associated with the Heine Boiler Co. as manager of the Central Sales District and with the Wickes Boiler Co. as general sales manager, and general manager of the heating division. In association with his son, J. R. Fortune, Jr., he established the firm bearing his name in 1932.

for defense against losses . . .

hang this economizer on your steam-cost curve

If your power plant dates back to the early twenties—if you are not using good heat recovery equipment—if you are pushing that plant twelve to twenty-four hours a day, we can pull your steam costs down.

The savings are, of course, dependent on your operating conditions. Basically, the installation of a Green Fuel Economizer will result in a one per cent fuel saving for every ten degrees rise in feed water temperature.

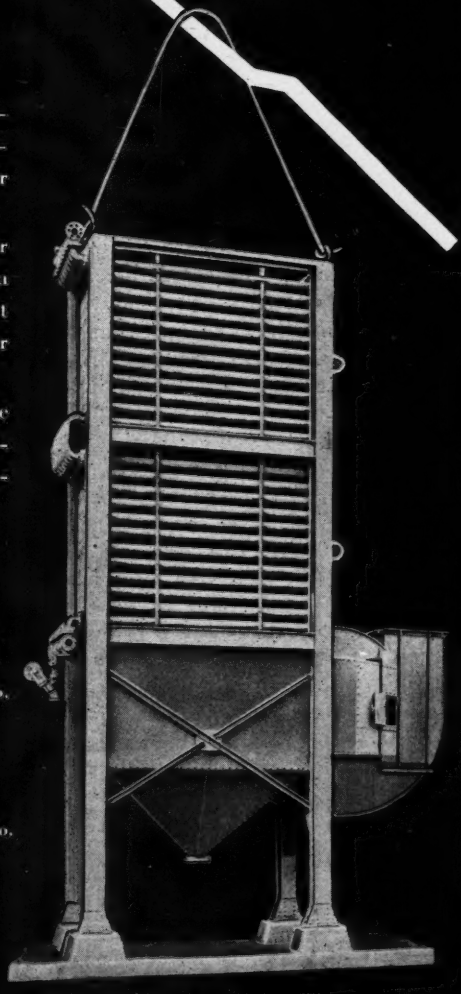
Service reports show that the savings effected the first year often exceed the first cost of this equipment—and then pay a substantial dividend throughout years of service.

Why not consult Green—*now*?

PARTIAL LIST OF RECENT INSTALLATIONS

Eddy Paper Co.	Sagamore Manufacturing Co.
Strathmore Paper Co.	Mueller Brass Co.
Bethlehem Steel Corp.	S. Stroock & Co., Inc.
Chase Brass & Copper Co.	Revere Sugar Refinery
Aetna Portland Cement Co.	Pacolet Manufacturing Co.
Lehigh Portland Cement Co.	Worcester County Electric Co.

Lincoln Bleachery & Dye Works



Green Cast Iron Fuel Economizers are manufactured in all sizes for pressures up to 450 pounds per square inch.

THE GREEN *Fuel Economizer* COMPANY INC.
BEACON NEW YORK

MECHANICAL DRAFT FANS · AIR PREHEATERS · ECONOMIZERS · CINDERTRAPS

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THIS is more than a war of mechanical monsters clashing in the night . . . more than a war of production.

It is a war for markets—*your* markets! The Axis wants your business—wants to destroy it for once and all.

With so much at stake, there is no doubt you will want to do everything you can to meet this Axis threat. Two ways are open: Speed production and BUY BONDS. The only answer to enemy tanks and planes is *more* American tanks and planes—and your regular, month-by-month purchases of Defense Bonds will help supply them. Buy now *and keep buying*.

HOW THE PAY-ROLL SAVINGS PLAN HELPS

When you install the Pay-Roll Savings Plan (approved by organized labor), you not only perform a service for your country but for your *employees*. Simple to install, the Plan provides for regular purchases of Defense Bonds through voluntary pay roll allotments.

Write for details *today!* Treasury Department, Section R, 709 Twelfth Street, NW., Washington, D. C.

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POWER PLANT ENGINEERING

Walter S. Rockwell

WALTER S. ROCKWELL, chairman of the board of the W. S. Rockwell Company, New York, builder of industrial furnaces, died recently at his home. He was 92 yr. old.

Mr. Rockwell, a native of Shelby, Ohio, founded the business in New York in 1888 and was its president until 1932, when he became chairman of the board. He was a member of the Ohio Society of New York.

William B. Willson

WILLIAM B. WILLSON, of East St. Louis, Ill., for over 28 yr. western sales manager of the Roto Co., Newark, N. J., tube cleaner manufacturers, died suddenly on May 8th at the age of 64. He was well known among refinery and power plant engineers, having spent his entire lifetime calling on these industries throughout the west.

New Engineering Books

American Standard Definitions of Electrical Terms. First edition, 300-p., 8 by 11 in. Dark blue fabricoid binding. Published by the American Institute of Electrical Engineers, 33 West 39th St., New York, N. Y. Price $1.00 net each in U.S.A. in single copies or in quantity. $1.25 outside U.S.A.

This new American Standards, sponsored by the American Institute of Electrical Engineers should mark an epoch in the literature of the electrical art in America as it is the first time the definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches have been assembled and printed under one cover.

This glossary is the result of more than twelve years' work of a sectional committee of 46 members having 18 subcommittees drawn from available specialists. More than 300 individuals have given material assistance and many others have assisted in specific instances. The 34 organizations represented on this sectional committee include the national engineering, scientific and professional societies, trade associations, government departments and miscellaneous groups.

The story of the origin of this work is as follows:

The International Electrotechnical Commission in 1910 appointed a committee on Nomenclature, for the purpose of drafting an international list of terms and definitions.

The first work of the IEC Advisory Committee on Nomenclature, under the chairmanship of the late Dr. C. O. Mailloux, consisted of making an exhaustive study of all the recognized systems for classification and numbering of terms in a technical glossary. The system employed in the new American Standard is that adopted at the Bellagio meeting of 1927 and employed in the international vocabulary of some 1860 terms issued in 1938.

For some time before the 1927 meeting of the IEC the U. S. National Committee IEC had been working toward the organization of a committee for the formulation of an American vocabulary, recognizing that the international list would inevitably cover but a fraction of the terms required for a serviceable American vocabulary.

The American Standards Association approved the initiation of the work in 1928 on the recommendation of the Standards Committee of the American Institute of Electrical Engineers, the scope being outlined as follows: "Definitions of technical terms used in electrical engineering, including correlation of definitions and terms in existing standards."

Under this authorization, the Sectional Committee on Definitions of Electrical Terms, C42, was organized during the same year, under the sponsorship of the AIEE and chairmanship of Dr. A. E. Kennelly. In 1932 the first report was printed, and 3000 copies were distributed for comment and criticism. In 1937 the second general revision was compiled and distributed. Early in 1940, C. H. Sanderson was appointed chairman (vacated in 1938 by the death of Dr. Kennelly) and the final preparation of the work for approval and publication as an American Standard was brought to a close in the Spring of 1941.

This new American Standard has unified and perfected the existing groups of definitions and has rounded out these groups and added many new groups. Its coverage is more than three times that of this field in any other language. It should prove of great value to the general public as well as to scientists and engineers for it is an extension of the function of the recognized dictionaries into specialized fields not hitherto covered.

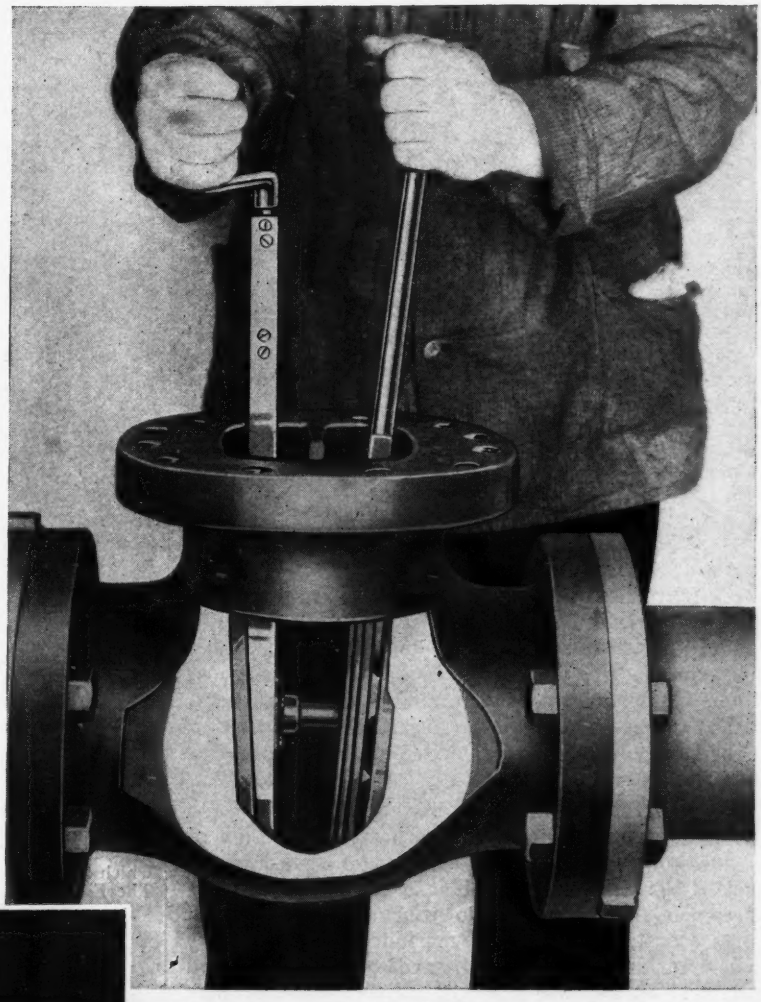
Reseat Without Removing the VALVE From the Line

Any mechanic using Dexter Equipment can reseat a valve (gate, globe or pump) in position,—can do it in an hour or less and make the seat and gate or disc, pressure tight.

Cutters are available for monel, stainless steel and stellite as well as brass and bronze.

Put an end to leaky valves in the line and salvage your old ones from your scrap pile. Dexter Equipment quickly pays for itself. Order today.

Capacities: Globe valves, ¼" to 14"; Gate valves, 1½" to 48"; Pump valves, 1½" to 15".



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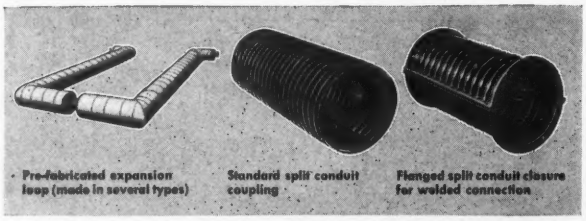
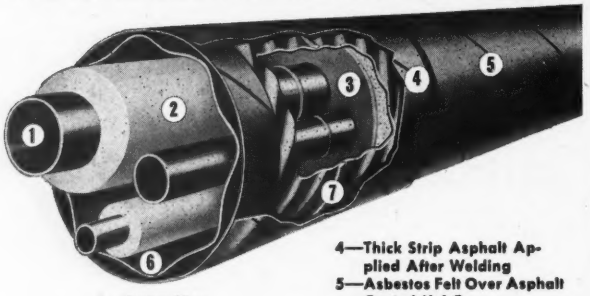
FOR SPEED!

UNDERGROUND STEAM CONDUIT

***Complete with* ALL EXPANSION LOOPS, ANCHORS, MANHOLES, FITTINGS, ETC.**



Pre-fabricated expansion loop (made in several types) | Standard split conduit coupling | Flanged split conduit closure for welded connection



1—Steam Pipe
2—Sectional Pipe Covering
3—Pipe Support
4—Thick Strip Asphalt Applied After Welding
5—Asbestos Felt Over Asphalt Coated Hel-Cor
6—Air Space
7—Butt Welded Construction

Ric-wiL Pre-Sealed Insulated Pipe Units are *fully* factory pre-fabricated. That means they include not only conduit, pipes, and insulation—but also all necessary pipe supports, pipe and conduit fittings, expansion loops, water-tight glands, pre-fabricated manholes, anchors, and any other accessories as specified. All provision is made *at the factory* for needed materials and parts to provide a complete job, ready for quick installation.

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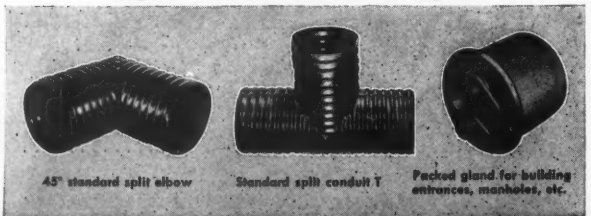
For Engineers on Defense Plants only: Ric-wiL Engineers' Manual 420A sent on request.



45° standard split elbow | Standard split conduit T | Packed gland for building entrances, manholes, etc.

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THE RIC-WIL CO., CLEVELAND, O.
Agents in Principal Cities

FOR THE ENGINEER'S LIBRARY

Coupon for obtaining free literature listed here may be found on page 164, under the heading Helpful Bulletins.

Pumps and Boiler Accessories

1 Pump Maintenance—The Stationary Instruction Manual is a 12-p. bulletin, well illustrated and covering in detail the installation, operation and maintenance of small pumps. The illustrations, a combination of photographs and cartoons, are well selected and show the various steps graphically. The text covers such points as installation, foundation bolts and grouting, alignment, suction lines, piping, relief valves, priming, starting, rotation, starting, packing, dismantling and reassembly with particular attention paid to pumps on standby service. Quimby Pump Co.

2 Pump Data—An 18-p. bulletin in a durable file folder containing an extra pocket for notes and hydraulic data covers the company's Pump Application Sheets formerly confidential but now released as a special war time service. These sheets of 2 to 8 p. each include elementary and advanced technical information on the selection, installation, operation and maintenance of all types of industrial pumps for general and special service. Gould's Pumps, Inc.

3 Tube Cleaners—A new 40-p. catalog of tube cleaning equipment features several new types of tube cleaning motors, cutter heads and accessories, and contains valuable information for power plant engineers. Complete tables of sizes of all motors, cutter heads and accessories are included to facilitate selection for any tube cleaning job; various types of motors, air, steam, water and electric, are grouped according to the motive power, and the last half of the catalog is devoted to cutter heads, brushes and other accessories. Thomas C. Wilson, Inc.

4 Try Cocks—Ernst Leak-Less Cocks are described in a new 2-p. bulletin covering low, medium and high pressure try cocks made in forged steel, stainless steel, Monel metal and bronze combinations. Circular TC. Ernst Water Column & Gage Co.

5 Oil Burning—Essential information and correlative tables covering all the factors governing industrial oil burning problems are described in a 4-p. bulletin titled Oil Burning Manual of Information. Combustion Equipment Division, The Hotstream Heater Co.

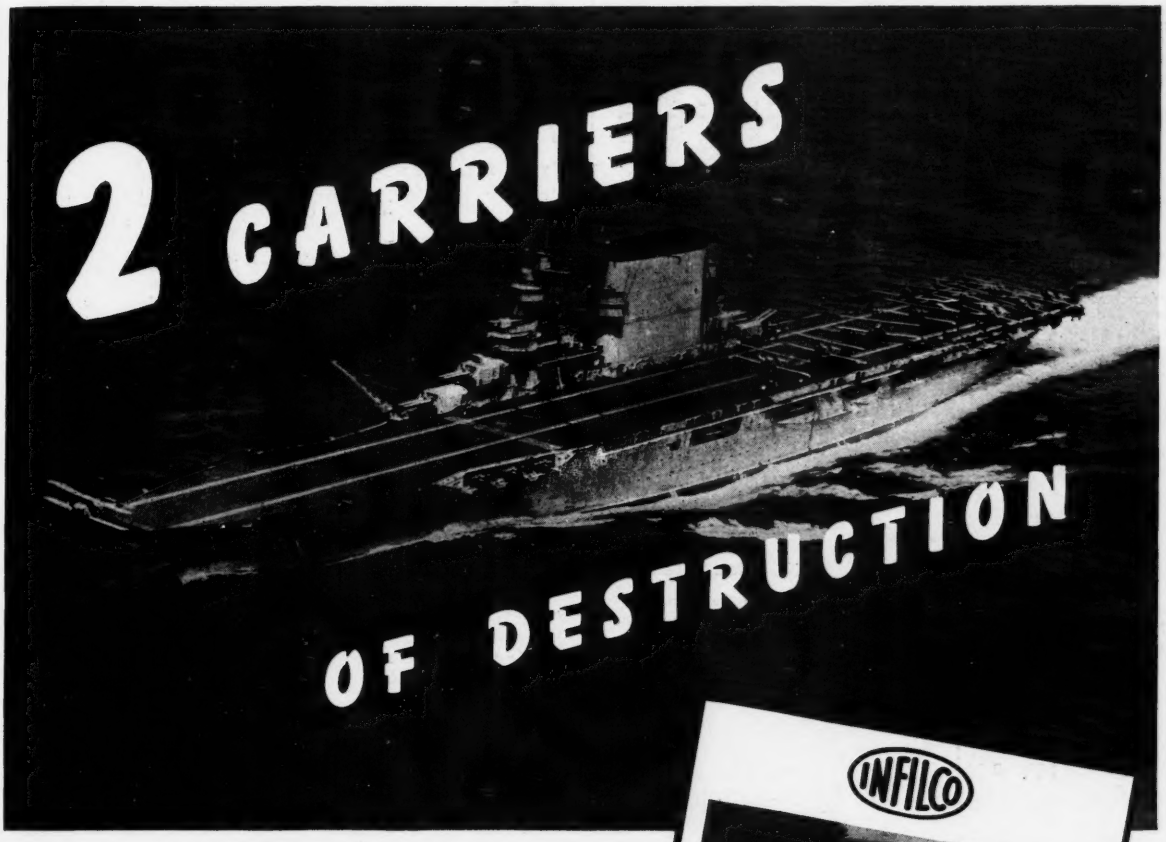
6 Ignition Systems—Automatic retractable oil-electric ignition systems for lighting off pulverized coal, oil or gas burners with remote control is detailed in a 16-p. catalog, which also gives specifications for installation and materials. The Engineer Co.

7 Smoke Recorders—Smoke density indicating and recording equipment is described in a 16-p. Catalog N-93-163. A schematic diagram shows how a continuously-flowing sample of smoke is drawn from stack, breeching or duct, and measured by a standard Micromax potentiometer recorder with the result continuously indicated and recorded in terms of smoke density. Full-size reproductions, scales and smoke density records are included. Leeds & Northrup Co.

Instruments and Controls

8 Level Controller—Fisher Bulletin F-1 gives complete specifications, illustrations, pressures and operating data on a new pilot operated, displacement type Level-Trol for controlling levels, interface levels, or specific gravity, or, as a level indicator. Available in five types for all pressures, temperatures and specific gravities. The Fisher Governor Co.

9 Radiation Pyrometers—A folder, Bulletin P1102 that gives the theory of operation and information concerning the use of a new line of radiation pyrometers is liberally illustrated with engineering drawings, showing typical applications. The Bristol Co.



Spectacular and instantaneous destruction results from the explosion of a Navy Bomber's torpedoes.

Destruction that is silent . . . perhaps slow . . . but nevertheless sure . . . can be carried by water into vital spots of your power plant.

Water . . . unless conditioned against scale, corrosion, embrittlement, oil, etc. . . . can destroy power plant equipment, efficient operation and fuel as effectively as a bursting torpedo.

Power plants, vital to the War Effort, are offered the protection of Infilco equipment for boiler and evaporator feedwater treatment, condensate oil removal, steam purification, cooling water conditioning, etc. The engineering staff and manufacturing facilities of this 48-year old organization are at your service.

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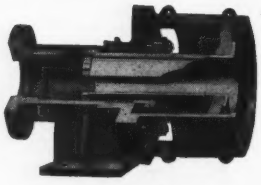
HOT-FLOW SOFTENERS • LIME-SODA SOFTENERS • ZEOLITE SOFTENERS

Photo Courtesy of Curtiss-Wright Corp.

BY SAFE-GUARDING STEAM LINES AT ARMY AND NAVY AIR BASES



From Pearl Harbor to Newfoundland; from Alaska to Pensacola; from San Antonio to Wright Field, the ADSCO Internally-Externally Guided Expansion Joint safeguards hundreds of miles of steam, hot water, fuel oil and gasoline lines by controlling expansion and contraction of pipe lines to hospital buildings, hangars, shops, and warehouses.

This completely guided joint meets Army and Navy specifications, and also has been approved for many years by leading mechanical engineers for installation in industrial plants, colleges, institutions, and railroad terminals.

The ADSCO Internally-Externally Guided Expansion Joint and other ADSCO products such as tile conduit, wood casing, meters, water heaters, steam traps, etc., reflect over 60 years experience in the manufacture of steam distribution equipment. For detailed information on ADSCO Products, write for Catalog No. 35E.

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Making "UP-TO-DATE" Steam Line Equipment for over 60 Years.

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10 **Potentiometer Pyrometers**—Catalog No. 1105 presents information on the design and operating features of potentiometer pyrometers and accessory equipment. Temperature measurement by the radiation method and automatic control systems are described and their operation explained. The Brown Instrument Co.

11 **Thermometers**—A 6-p. bulletin T 302 on fully compensated liquid filled thermometers for temperatures between minus 125 deg. F. and plus 400 deg. F. gives full details concerning the construction of the instruments, the various types and information on their application. The Bristol Co.

12 **Controllers**—Complete data on the Bristol line of non-indicating temperature and pressure controllers are given in 36-pp. catalog 900-E. A self-operating controller used where compressed air or electricity is unavailable is new in design and fully explained. C. J. Tagliabue Mfg. Co.

13 **Valve Operators**—Catalog A14 is a 12-p. treatment of electric motor valve operators as applied to standard temperature control systems. Data are tabulated and wiring diagrams shown. Automatic Temperature Control Co.

14 **Pumping Controls**—Controllers of the recording and indicating type are shown, with specimen charts and installation photos in Bulletin B-294. In addition to waterworks and engineering information, pumping applications common to industry are detailed. The Foxboro Co.

15 **Speed Recorders**—12-p. catalog N-27 describes instruments which measure and automatically record speed of rotating machinery with high accuracy and reliability to help management set up efficient operating schedules and provide operators with an accurate guide for regulation. Leeds & Northrup Co.

Electrical Equipment

16 **Switchgear**—Condensed Catalog 426 (84-p.) superseding Catalog 421 issued last January, shows changes made in the Bull Dog line in the interest of simplification and conservation of critical materials. The complete Bull Dog line including safety switches, service equipment, panels, switchboards and circuit breakers is shown with colored sections highlighting the Bus Duct and Trol-E-Duct systems. Bull Dog Electric Products Co.

17 **Switchboard Instruments**—Direct current and alternating current indicating instruments for mounting on switchboards are described in a new 12-p. catalog No. 4220. These include ammeters, voltmeters, wattmeters, frequency and power factor meters, synchroscopes, rectangular triplex ammeters, and horizontal edgewise triplex ammeters in round surface mounting models and square surface or flush models. Roller-Smith Co.

18 **Dynamotors**—GEA 3776 is a 4-p. folder on the construction and use of GE dynamotors (in effect direct current transformers) made in sizes from 25 to 600 w. One winding furnishes driving power to produce a different voltage from the second winding. General Electric Co.

19 **Synchronous Motors**—A 4-p. leaflet L-20655 describes the application of synchronous motors for coupled, belted and geared service and explains their distinctive features and operating characteristics. Westinghouse Elec. & Mfg. Co.

20 **Network Systems**—A power distribution system for industrial plants that combines flexibility, reliability and voltage regulation, and can be easily extended by adding additional units is the subject of Booklet B-3120. Power is carried into the plant at high voltage and the network units are located at the load centers, each with two or more sources of power. Westinghouse Elec. & Mfg. Co.

21 **Cable**—GEA-3801 describes the easy installation of oil and acid resisting bus-drop cables for 600-v. branch circuits. Included are details of construction and installation together with advantages. General Electric Co.

22 **Power Cable**—GEA 3656 is an 8-p. bulletin of information on power cables for industrial plants. Data are included, typical illustrations are shown. Voltage regulation is discussed and tables show how materials and money savings can be made. General Electric Co.

HOW TO AVOID A

Fuel Problem

IN YOUR BOILER ROOM

In the race against TIME—when production goals demand that boilers operate at peak efficiency 24 hours a day, 7 days a week—the immediate scarcity and possible elimination of oil as a fuel is a threat that cannot be ignored. Now as never before it is well to look the facts in the face and PLAN the immediate future of your boiler room.

Many power plant operators have converted their oil-fired boilers into coal-fired boilers economically and quickly by installing an "F&E" manufactured "Huber" Hand-Fired Stoker. It is the ideal changeover equipment —low in cost, simple and inexpensive to install, obtainable in a comparatively short time. Efficiencies and capacities far in excess of those reached with ordinary hand-fired equipment are possible.

The "Huber" Hand-Fired Stoker has served thousands of plants successfully for more than twenty-five years. NOW—it is the practical answer to the present fuel problem.

Ask the "F&E" representative in your territory to show you the details of this equipment — show you the economies and advantages of changing over to coal NOW—with the "Huber" Hand-Fired Stoker.

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ESTABLISHED 1842 F&E BALTIMORE, MD.

Manufacturers of
'F&E' UNDERFEED STOKERS—'HUBER' OVERFEED STOKERS—'HUBER' HAND-FIRED STOKERS—'HUBER' SECTIONAL BOILER FRONTS

GREATER CAPACITY • LESS LABOR
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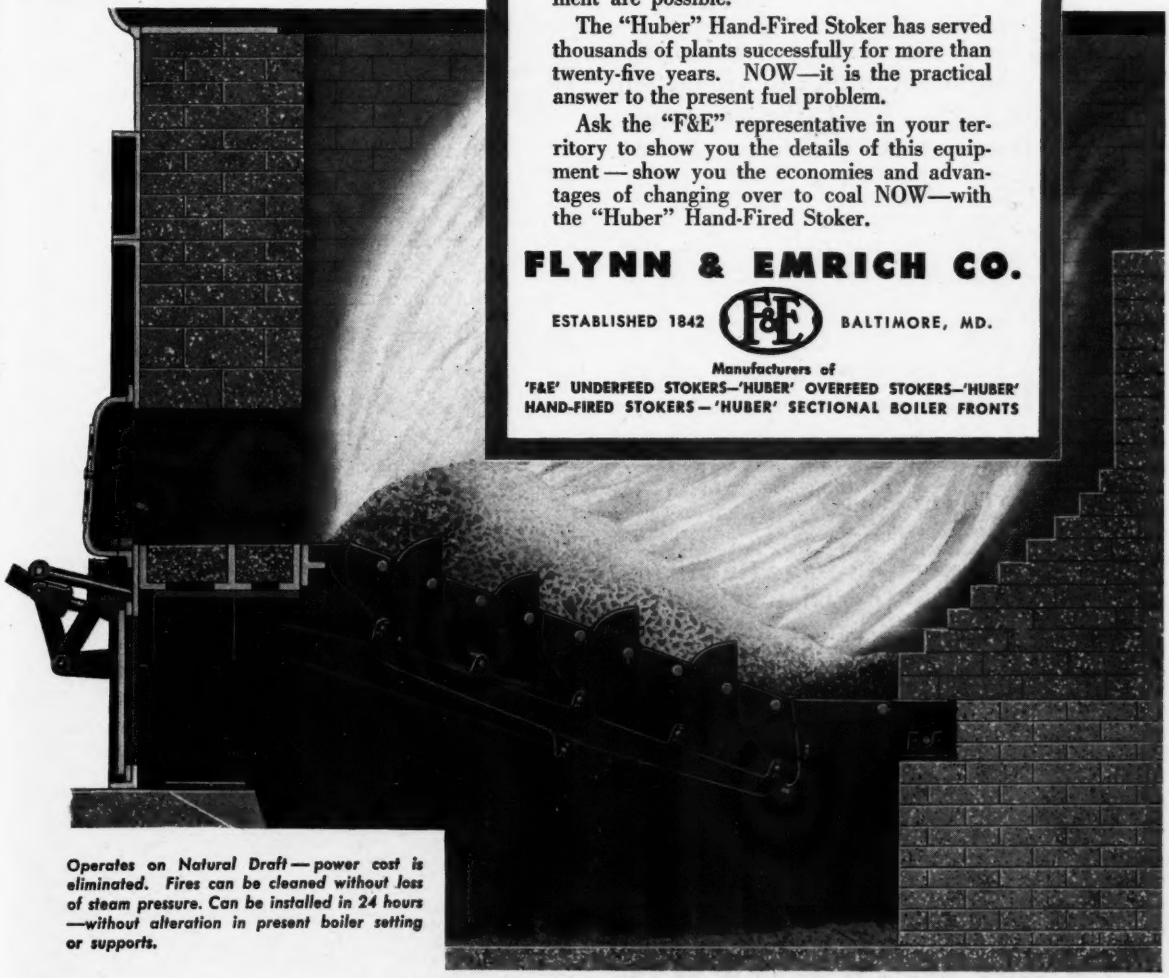
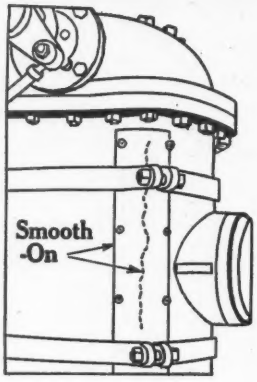


Operates on Natural Draft — power cost is eliminated. Fires can be cleaned without loss of steam pressure. Can be installed in 24 hours —without alteration in present boiler setting or supports.

How SMOOTH-ON will help you maintain production schedules



dozens of plant repairs can be made with Smooth-On No. 1

Every repair on a cracked casting or a leaking seam means loss of time which, today, may be even more important than the money cost of the repair.

To cut down repair time on many trouble jobs that would cause interruptions to production . . . use SMOOTH-ON No. 1, the iron repair cement of a thousand uses, proven by 47 years on the market.

SMOOTH-ON repairs do not require dismantling of apparatus, the use of heat, or special tools.

SMOOTH-ON is the speediest way of repairing cracks, leaks and loose parts, and the results are lasting. That is why experienced engineers all over the country always make sure to keep a can of SMOOTH-ON handy.

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Do it with **SMOOTH-ON**

23 Feeder Voltage Regulators — Air-Cooled induction feeder voltage regulators of from 12 to 24 kv-a. and especially designed for feeder circuits and industrial plants, are described in a new 11-p. bulletin 47-175. Electrodynamic braking phase angle, adjustment, a new regulating relay, operation and construction are fully covered. Westinghouse Elec. & Mfg. Co.

24 Air Circuit Breakers — Catalog 2150 describes low-voltage air circuit breakers designed for use on alternating current circuits up to 600 v. and direct current circuits of 250 to 750 v. The catalog lists closing and tripping currents, shows typical methods of making connections to large breakers, gives dimensions of both manual and electrical designs, and indicates the number and size of terminals for various capacity breakers. Roller-Smith Co.

25 Voltage Regulation—Undervoltage is the title of GES 2973, a spectacular presentation in colors of the effect of voltage on lighting efficiency in relation to war production. It tells why undervoltage is bad, how it can be corrected and lists case studies of what proper control will do in production increase and dollar savings. General Electric Co.

26 Pyranol Transformers—Getting safety and savings in power distribution is the theme of the 20-p. plastic bound Catalog GES 2974. The advantages of Pyranol transformers in their application and installation in industry is thoroughly illustrated and described. General Electric Co.

27 Sectional Resistors—An 8-p. Catalog 43-820 deals with sectional resistors, non-inductive, wire wound, and hermetically sealed, for a.c. and d.c. circuits. The bulletin includes tables which give size, voltage resistance and price. The resistors ratings are from 250 to 30,000 v. for switchboard mounting or portable use. Westinghouse Elec. & Mfg. Co.

Miscellaneous

28 Heat Insulation—A new 16-p. illustrated catalog covers an expanded line of BH heat insulation products from blocks and blankets to building insulation materials. Methods for application are detailed and calculations facilitated by several charts showing the temperature, heat loss and insulation thickness relations. Baldwin-Hill Co.

29 Conduit—Catalog S is a 12-p. two color engineering bulletin and catalog on underground and overhead prefabricated units and tile conduit systems. Shown are typical conduit fittings, pipe supports, glands, and prefabricated expansion loops complete with engineering details and suggested specifications. The Ric-wil Co.

30 Rubber Belts—In the interest of rubber conservation, a useful wall card, Form No. 6576, gives complete instructions for the proper installation and care of rubber transmission belts, V-belts and conveyor belts. The card, measuring 8¾ by 11 in., has an eyelet for convenient hanging. The Manhattan Rubber Mfg. Division.

31 Graphite Lubricant — Bulletin 4, 2-p., describes the application of a recently developed product, Konag F, an all purpose colloidal natural graphite additive for lube oils and many greases. It is claimed that the product forms a tough and durable graphoid "skin" and steps up the lubricating value of oil and is not affected by acid fumes or vapors. National Graphite Co., Inc.

32 Machine Tools—Catalog 542, 4-p., gives complete information and specifications concerning standard Morse taper live centers for machine tool operations. Sturdimatic Tool Co.

33 Locknuts—A comprehensive 6-p. folder on An-cor-lox lock nuts gives factual information on materials, designs and finishes, instructions for application and shows illustrations of typical uses. Laminated Shim Co., Inc.

34 Engine Reconditioning—Pedrick's Service Manual is a new 60-p. booklet devoted to a discussion of accepted practice in general motor reconditioning with special emphasis on piston ring installation. Some 20-p. give data on specific engines, arranged alphabetically by engine make. The Wilkening Mfg. Co.

35 Air Diffusers—Three bulletins cover the use and application of Anemostat equipment. No. 10, 4-p., entitled Air Conditioning—Success or Failure, outlines the general

OUR DUAL OBJECTIVE

WORTHINGTON EQUIPMENT
for
POWER GENERATION
and
INDUSTRIAL SERVICE

STEAM TURBO-GENERATOR UNITS
MULTI-STAGE STEAM TURBINES
SINGLE-STAGE STEAM TURBINES
COMBINED STEAM TURBINE AND REDUCING GEAR UNITS
REDUCING AND INCREASING GEARS
DIESEL ENGINES
GAS ENGINES
CONVERTIBLE GAS-DIESEL ENGINES
STEAM CONDENSERS
STEAM JET EJECTORS
CENTRIFUGAL BOILER FEED PUMPS
CENTRIFUGAL GENERAL SERVICE PUMPS
AIR AND GAS COMPRESSORS
FEEDWATER HEATERS AND DE-AERATORS
WATER FILTERS
WATER SOFTENERS
REFRIGERATION AND AIR CONDITIONING EQUIPMENT
TURBINE WELL PUMPS
STEAM, POWER AND ROTARY PUMPS
LIQUID METERS
V-BELT DRIVES
PORTABLE AIR COMPRESSORS
CONSTRUCTION AIR TOOLS

WORTHINGTON products are not built to serve for this period of emergency only, but to continue to operate for many years after industry returns to peace-time pursuits. Therefore there can be no letting down of the rigid standards that have been set for them as a basic Worthington principle.

It is our aim that Worthington equipment produced during this difficult period shall accomplish two purposes . . . first that it shall serve effectively and without interruption, on the many important jobs which it fills . . . and second that, in so doing, it shall make new friends, and retain the confidence of old friends.

To those plants where Worthington equipment is now in use, we offer the services of our district office engineers, and our headquarters staff, in checking conditions and performance, with a view to assuring continued operation at top efficiency.

And in the planning for readjustment or expansion, whether for the war production program or the period to follow, the counsel of these specially qualified engineers is always available. M12-18

WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices: HARRISON, NEW JERSEY

WORTHINGTON

More Power to You–

And Here's How to Make Sure of it

WHAT TO DO to keep your water columns and gages protecting your boilers for the duration

MAINTENANCE schedules should cover boiler water level indicating equipment as thoroughly as any other vital operating devices. It will pay you to review these points of good boiler room practice.

1 **Water Column.** Open blowdown valve at start of each shift to flush sediment from column and to test low water alarm signal. *Open and close valve slowly to avoid water shock.* When operating conditions permit, raise boiler water level sufficiently to test high alarm signal, to insure constant readiness for emergency warning.

2 **Gage Valves.** Open blowdown valve at start of each shift to remove sediment. Observe speed at which water returns to proper level. This indicates whether gage valve ports are unobstructed. Keep packing tight around valve stem and glass — leakage wastes steam and causes dirty deposits that look bad and hinder operation when quick action is essential.

3 **Gage Glass.** Cleanliness is vital to good vision. Whether you are using tubular glass or an expensive insert, the glass must be *clean* for accurate reading. You know from experience how long a tubular glass may be used on your boilers before it is thinned to the danger point. Change glasses regularly. Also be sure tubular glasses have guards to prevent injuries.

4 **Gage Glass Inserts.** Prismatic and Flat Glass Water Gage Inserts, if used, should be inspected frequently for possible leakage. Expansion and contraction from temperature changes may loosen bolting pressure. A slight "take-up" may prevent blowing out of gaskets and reduce glass erosion.

5 **Mica.** Whether used as a protective coating to prevent glass erosion or as an insert window, treat mica with *utmost care.* All mica for this service is imported and replacement stocks limited. When possible, clean mica with alcohol or other solvent and replace in service. Otherwise salvage all mica possible by "splitting" and rebuilding to proper thickness with replacement sheets.

6 **Illumination Equipment.** Keep reasonably clean at all times to insure full visibility. Use proper size lamp. Most illuminators are constructed to focus maximum light rays from a definite location of lamp filament. Where mirrors are employed, check cleanliness and adjustment regularly.

7 **Gage Cocks.** Test daily to insure readiness for emergency operation. Frequent testing causes less wear than occasional use because sediment is not allowed to accumulate in quantity. Never leave a gage cock "sizzling"— open it for blowdown two or three times if necessary to remove the scale which may cause wire drawing and an early repair job.

8 **Remote Reading Indicators.** Familiarize yourself thoroughly with the manufacturer's instructions for proper care and follow them in detail. Don't let an indicator remain in service which may be inaccurate. Hang a warning sign on it until it can be serviced — *remember the man on the next shift!*

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Avenue, Cleveland, Ohio

TRADE MARK · REG. IN U.S. PAT. OFF.
Reliance
Boiler Safety Devices since 1884

problem. No. 13, 4-p., illustrates the various types of wall and ceiling Anemostats for room ventilation. No. 16, 4-p., covers the use and data on equalizing dampers used in the ducts to give additional equalized directional and volume control. Anemostat Corp. of America.

36 **Waterproofed Concrete**—How to Waterproof Concrete, Stucco and Masonry is the title of a 12-p. booklet which explains the problem, different methods used and the advantage of waterproofing. Drawings show typical construction practice. Medusa Portland Cement Co.

37 **Metal Alloys**—Machining Monel, R Monel, Inconel, K Monel, KR Monel and Nickel are discussed in 16-p. Technical Bulletin T-12. Included is additional discussion of R Monel and KR Monel, recommended cutting feeds and speeds based on machining practice, band sawing and data on results of drilling tests on cast material. The International Nickel Co., Inc.

38 **Safety**—A 4-p. pamphlet Horse Sense gives valuable information on equipment to reduce accidents through the intelligent use of compressed air. The safety installations described are easy to install and operate. A. Schrader's Son.

39 **Priority Forms**—Intended solely to assist customers and jobbers to play their part in winning the war, a 16-p. booklet, Priorities Mobilize Production for Victory, explains priorities and the types of forms and certificates used. Manning, Maxwell & Moore, Inc.

40 **Bleaching Agents**—Fifty Years of Chemical Progress, is the title of a 48-p. booklet that traces the growth and the company's progress in the introduction of liquid chlorine, bleaching agents and detergents. Mathieson Alkali Works, Inc.

Special Request Bulletins

Group Hospitalization and Insurance—A new, low-cost Employe Group Insurance Plan, designed to promote employe security and good-will, recently announced, is described in detail in a new booklet. The policy lists cash payments for hospitalization expense in case of sickness or

(Continued on Page 166)

Use the Coupon to Get HELPFUL BULLETINS

Bring your engineering equipment library up to date. Write in squares below with pencil the bulletin or catalog numbers you desire. Then detach and mail this coupon promptly.

POWER PLANT ENGINEERING July, '42
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Please have the manufacturers send me, without obligation, the bulletins indicated by numbers.

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Name .....

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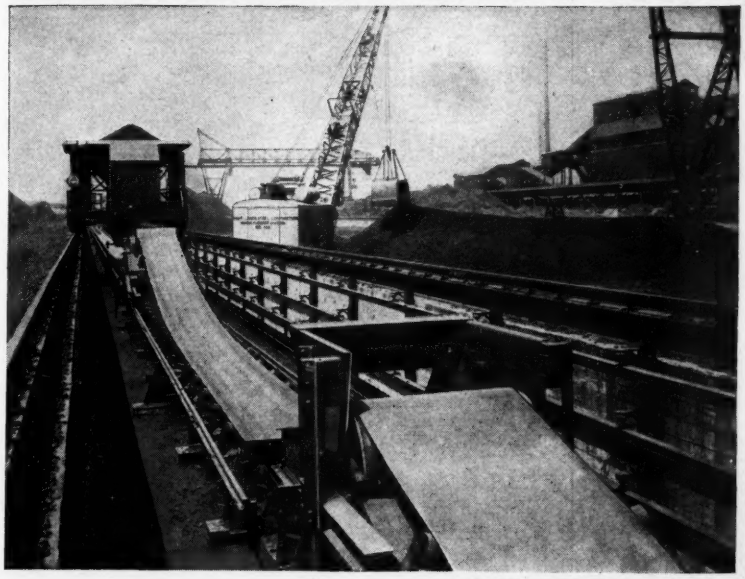
PLAN for Adequate Coal Storage NOW

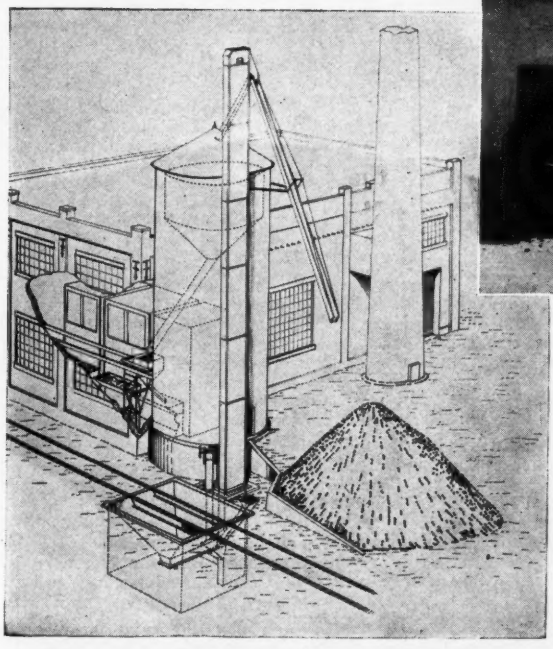


A complete Link-Belt system of handling coal from self-unloading lake vessels direct to plant or to storage piles or from storage to plant, as desired. Employs three standard Link-Belt Speed-o-Matic cranes, belt conveyors, traveling reclaiming hoppers, a traveling reciprocating feeder and a portable stacker-conveyor. Flexible, efficient, high capacity.

•

Link-Belt Speed-o-Matic crawler crane unloading coal from railroad cars to storage pile at power plant.

★ ★ ★



A simple, versatile, economical power plant coal storage method—the Link-Belt silo system. This system combines all handling functions in a simple, compact unit, suitable for either new or existing installations. Usually silos are located adjacent to the boiler house but constructed independently, and equipment within the boiler house consists entirely of means for distributing the coal. Frequently a single spout from the silo is all that is needed. Silos may be designed for normal storage requirements or equipped with auxiliary spout to provide additional outside reserve storage when desired. Link-Belt's broad experience in the art of storing and reclaiming coal is available to you.

LINK-BELT COMPANY, Chicago, Philadelphia, Indianapolis, Atlanta, Dallas, San Francisco, Toronto. Offices in principal cities. 8904

LINK-BELT

... Coal And Ashes Handling Equipment

CONVEYORS • ELEVATORS • SKIP HOISTS • CRUSHERS • LARRIES • SCREENS

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it's FREE!
Just attach your letterhead to this ad to get your copy
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Will expedite your job as a finger-tip reference book
it's COMPLETE!
44 useful pages of fittings information, and engineering data
Forged
STEEL FITTINGS
WATSON-STILLMAN
HERE'S A BOOK YOU NEED!

It puts just the data you want at your finger tips in easy-to-use form. It includes three useful sections:

1. SCREWED FITTINGS for 2,000, 3,000, 6,000 lb. pressures.

2. SOCKET WELDING FITTINGS for schedule 40, schedule 80, schedule 160, and double extra heavy pipe.

3. ENGINEERING TABLES: Codes, calculations, specifications.

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. . . don't bother to write — just clip this ad to your letterhead, sign it, and send. We'll know what you want without a word. When you get it you'll find a complete reference book containing a wealth of handy data in its 44 helpful pages. Included are 100 illustrations, 78 drawings, and 12 pages of essential engineering tables, charts, and data.

Of course there's no obligation—but . . . remember our engineers have the "know-how" that has maintained W-S leadership in the fittings and hydraulic fields for nearly a century. They are at your service in war as in peace. Never hesitate to call on them for expert advice. The Watson-Stillman Co., Roselle, New Jersey.

2735

accident, surgical expense, maternity confinement expense, compensation for time lost from work, loss of life through accident, loss of life through natural cause and physical dismemberment. Any size group is eligible, in factory office, shop, store, etc. Family dependents may be included at the option of the employe. Premiums, a few pennies a day, are paid by the employe. No medical examination is required. No age limit. Descriptive brochure will be sent without obligation to company heads upon request on business letterhead. North American Mutual Insurance Co.

Plant Personnel—A 40-p. booklet, Building Production Morale, illustrates war production operations and morale methods in effect at the Northern plant. It was prepared and published at the suggestion of the U. S. Navy, and contains a foreword by Rear Admiral H. A. Wiley. Copies are available upon a separate written request. Northern Pump Co.

COAL STORAGE MANUAL AUTHORS

Ralph E. Turner, Editor of POWER PLANT ENGINEERING, was born at Columbus, Neb., and graduated from the University of Nebraska in 1906 with a bachelor's degree in electrical engineering. After several years' experience as erecting engineer for Westinghouse Electric & Mfg. Co., he joined the editorial staff of POWER PLANT ENGINEERING in 1908, serving as assistant editor, managing editor and, since 1938, as editor. He is active in the Western Society of Engineers, American Society of Mechanical Engineers and the National Conference of Business Paper Editors and is a past chairman of the Chicago Section of the A.S.M.E.

George C. Daniels, in charge of the Mechanical Engineering Dept. of The Commonwealth & Southern Corp. in Jackson, Mich., graduated from the University of Wisconsin in 1908 with a bachelor's degree in mechanical engineering. Soon after graduation he entered the utility field with the Central Illinois Light Co. at Peoria, and has been active in the operation, design and construction of power plants since that time with: the Hodenpyl Hardy Co.; Central Illinois Light Co.; Illinois Power Co.; Springfield Light, Heat & Power Co.; the Commonwealth Power Co.; and, since 1928, in his present position.

Carroll F. Hardy, head of the Fuel Engineering Division of Appalachian Coals, Incorporated, Cincinnati, Ohio, received his education at Purdue University and joined the Fuel Engineering Staff of Appalachian Coals in 1937, after 8 yr. in the Plant Engineering Division of the Newcastle, Ind., plant of the Chrysler Corp. He is also a director of engineering for the Coal Producers Committee for Smoke Abatement, an organization devoted to sensible and permanent smoke abatement work.

M. K. Drewry, assistant chief engineer of power plants of the Wisconsin Electric Power Co. at Milwaukee, graduated from the University of Wisconsin with a bachelor's degree in mechanical engineering. After graduaton he completed a student engineer's course at Allis-Chalmers Mfg. Co. and soon after became test engineer of the Milwaukee Electric Railway and Light Co., predecessor of the present Wisconsin Electric Power Co.

Raymond J. Brandon, Technical Assistant in the Production Department of Trenton Channel Power House of The Detroit Edison Co., graduated from Yale Sheffield Scientific School in 1928 with a bachelor's degree in mechanical engineering. He immediately joined The Detroit Edison Co. and has been with them continuously up to the present time. Of recent years Mr. Brandon has been in responsible charge of technical fuel problems involved in the selection, storage, preparation and sampling of coal and related combustoin problems.

Joseph Harrington, Advisory and Research Engineer of the Northern Illinois Coal Corp., graduated from Massachusetts Institute of Technology in 1896 with a bachelor's degree in mechanical engineering. Since then he has had a long and distinguished career as a consultant, designer and inventor and is probably best known as the designer of the Green Chain Grate stoker, the Harrington stoker and the Whiting stoker. During the first World War he was Administrative Engineer of the U. S. Fuel Administration for Illinois in charge of coal conservation in 13,000 power plants. He is also a former presidential member of the Bituminous Coal Code Authority, Division 11 and in February, 1940, was the recipient of the award as Modern Pioneer from the National Association of Manufacturers.

New Target for Industry:

More Dollars Per Man Per Month in the PAY-ROLL WAR SAVINGS PLAN

TO WIN THIS WAR, more and more billions are needed and needed fast—AT LEAST A BILLION DOLLARS A MONTH IN WAR BOND SALES ALONE!

This means a *minimum* of 10 percent of the gross pay roll invested in War Bonds in every plant, office, firm, and factory in the land.

Best and quickest way to raise this money—and at the same time to "brake" inflation—is by stepping up the Pay-Roll War Savings Plan, having every company offer every worker the chance to buy MORE BONDS.

Truly, in this War of Survival, VICTORY BEGINS AT THE PAY WINDOW.

If your firm has already installed the Pay-Roll War Savings Plan, *now is the time*—

1. To secure wider employee participation.
2. *To encourage employees to increase the amount of their allotments for Bonds, to an average of at least 10 percent of earnings—because "token" payments will not win this war any more than "token" resistance will keep the enemy from our shores, our homes.*

If your firm has not already installed the Pay-Roll War Savings Plan, *now is the time to do so.* For full details, plus samples of result-getting literature and promotional helps, write, wire, or phone: War Savings Staff, Section E, Treasury Department, 709 Twelfth Street NW., Washington, D. C.

U. S. War Savings Bonds

This space is a contribution to America's all-out war program by

POWER PLANT ENGINEERING

Form No. WSS-BP-5

16—25443-1 U. S. GOVERNMENT PRINTING OFFICE

Power Plant Construction News

Ark., Newport—War Department, Twentieth St. and Constitution Ave., N. W., Washington, D. C., has authorized a new air force training school in vicinity of Newport. A boiler house and power substation will be built, with complete electric light and power distribution system. Entire project will cost over $3,000,000 and will be carried out soon. U. S. District Engineer Office, Little Rock, Ark., is in charge.

Conn., Bridgeport—United Illuminating Co., 80 Temple St., New Haven, Conn., will begin superstructure soon for addition to Steel Point steam-electric generating station, Bridgeport, for expansion in steam-generating division. Award for building erection has been made to Gellatly Construction Co., 25 Housatonic Ave., Bridgeport; contracts for equipment are being placed separately. Entire project will cost over $1,000,000.

Ill., Chicago—Republic Steel Corp., 11800 S. Burley Ave., has approved plans for new steam-electric generating plant at local works on 115th St., to be 2-story, about 70 by 120 ft. Cost reported close to $1,000,000 with equipment. Building permit has been issued and work will proceed at once. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is consulting engineer and will supervise erection.

Ind., Gary—Rubber Synthetics, Inc., care of Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, Ill., recently organized by officials of that company and other oil and industrial interests, plans power station and boiler house at new synthetic rubber mill in vicinity of Gary, for production for Government. It will consist of a large group of one and multi-story production and processing units. Entire project will cost close to $100,000,000, with financing to be provided by Defense Plant Corp., Washington, D. C. Work will begin soon.

Iowa, Keokuk—Swift & Co., Union Stock Yards, Chicago, Ill., meat packers and manufacturers of prepared food products, plans boiler house at new egg dehydration plant at Keokuk, to consist of several large one and multi-story units. Electric power equipment will be installed; a power substation will be built. Cost about $1,000,000, with financing to be provided by Agricultural Adjustment Administration, Washington, D. C., a Federal agency. Work will begin soon.

Iowa, Muscatine—Publicker Commercial Alcohol Co., 1800 W. Lehigh Ave., Philadelphia, Pa., plans installation of electric power equipment in proposed new plant in vicinity of Muscatine, for production of alcohol for Government. It will comprise a main one and multi-story unit and several auxiliary structures. A power house is planned. Cost reported over $1,000,000.

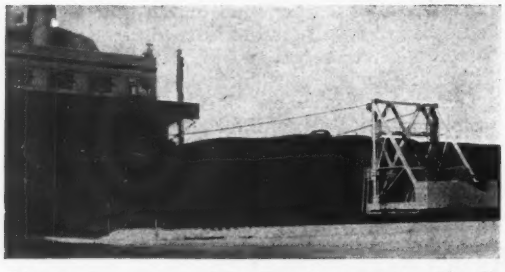
Mass., Quincy—Bethlehem-Hingham Shipyard, Inc., East Howard St., Quincy, an interest of Bethlehem Steel Co., Ship Building Division, same address, plans installation of electric power equipment in new shipbuilding plant on Weymouth Back River (exact location withheld), for production of vessels for Government. Yard will comprise a series of 16 shipways, with shops, boiler house and other structures. Cost close to $3,700,000, to be defrayed in part by Government.

Mich., Port Huron—Water Department, Port Huron, plans pumping plant in connection with extensions and improvements in municipal water system. Surveys and estimates of cost for entire project are being made by Ayres, Lewis, Norris & May, Wolverine Building, Ann Arbor, Mich., consulting engineers.

Neb., Lincoln—E. I. duPont de-Nemours & Co., Inc., duPont Building, Wilmington, Del., plans steam power plant at proposed new chemical plant in Nebraska (exact location withheld) for production for Government. It will consist of several large one and multi-story buildings. Electric power

Store Coal Now...and Aid Defense

Here is a 30,000-ton coal pile on a 200 x 350 ft. area. The storing and reclaiming machinery is a 1 cu. yd. Sauerman scraper system powered with a 40 hp. electric motor. This machine will handle up to 75 tons per hour.



This view shows a 7 cu. yd. Sauerman Scraper system with self-propelled tail tower that handles upwards of one million tons of coal per year (both storing and reclaiming) for a 160,000 kw. generating station.

IT is essential to the war effort that all steam plants build up their coal reserves before the fall rush places the usual heavy load on shipping facilities.

Any plant that lacks adequate facilities for stock-piling coal can remedy matters quickly and economically by installing a Sauerman Power Drag Scraper. This labor-saving equipment offers the most simple, efficient and least expensive solution of the average coal storage problem.

Advantages of SAUERMAN Scraper System

Economy—**Capital cost is low. Machine is operated by one man. About ¼ kwh. of power is consumed for every ton of coal moved 100 ft. Maintenance averages about ½c per ton stored or reclaimed.**

Flexibility—**No matter what the shape of an area, the scraper makes complete use of the space. Coal is reclaimed from any point in the pile just as easily as it is stored.**

Minimum Fire Hazard—**Scraper spreads the coal in well packed layers, so that there are no air pockets to create hot spots.**

WRITE FOR CATALOG • SAUERMAN BROS., Inc., 586 S. Clinton St., CHICAGO

equipment will be installed; a power substation is planned. Entire project will cost over $3,000,000. Financing will be provided by Defense Plant Corp., Washington, D. C.

N. J., High Bridge—Taylor-Wharton Iron & Steel Co. plans extensions and improvements in steam power plant at local iron and steel works. Cost reported over $50,000, including equipment.

N. M., Carlsbad—Union Potash & Chemical Co., 20 N. Wacker Dr., Chicago, Ill., plans expansion and improvements in power plant at potash properties at Carlsbad, including installation of equipment for increased capacity. Cost estimated over $250,000. Work will begin soon. Company is a subsidiary of International Minerals & Chemicals Corp., first noted address.

Ohio, Cincinnati—Cincinnati Gear Co., 1825 Reading Rd., manufacturer of gears, gearing systems, etc., plans steam power plant at new 1 and 2-story works, about 80 by 400 ft., in Westover subdivision area. Entire project will cost over $200,000. Electric power equipment will be installed for works service. John H. Deeken, 800 Broadway, Cincinnati, is architect.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., 321 N. Harvey St., will carry out expansion at A. S. Huey steam-electric generating station in near future, to include installation of new 20,000-kw. turbine-generator unit and auxiliary equipment, scheduled for completion in July, 1943. This is part of 1942 construction program of company, for which total fund of $2,450,000 recently was authorized.

Okla., Tulsa—Associated Refineries, Inc., care of M. Lloyd Freeze, Bell Oil & Gas Co., Tulsa, president, recently organized by Bell company and a number of other oil and gas companies in same area, plans power house at proposed new oil refining plant in Southern part of State (exact location withheld. It will be used for production of high-test gasoline for Government and is estimated to cost about $10,000,000. Also will install pumping machinery, power equipment, high pressure steel tanks, etc. Financing will be provided by Defense Plant Corp., Washington, D. C.

Pa., Erie—Erie Lighting Co., 21 W. Tenth St., has approved plans for new multi-story addition, about 100 by 400 ft., to steam-electric generating station. Additional equipment will be installed for increased capacity. Work is scheduled to begin at early date. Cost reported over $350,000, exclusive of equipment.

Texas, Houston—Humble Oil & Refining Co., Humble Building, Houston, plans boiler plants at two new mills for production of butadiene, a basic ingredient of synthetic rubber, and synthetic rubber, respectively, on sites in Texas (exact locations withheld). Each plant will comprise several production and processing buildings, equipped for large output. Electric power equipment will be installed. Entire project will cost about $43,000,000, with part of fund to be provided by Defense Plant Corp., Washington, D. C., and remainder by company.

Va., Richmond—Virginia Electric & Power Co., Richmond, has plans under way for new steam-electric generating station on site on James River, Chesterfield County, to be equipped for initial capacity of 50,000-kw. Cost estimated over $6,500,000, with turbine-generators, high-pressure boilers and auxiliary equipment, switchyard and extensions in transmission lines. Proposed to begin work soon, with completion scheduled in fall of 1943. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer and will supervise erection.

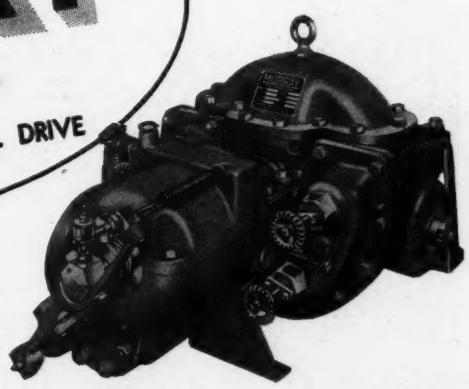
Wash., Yakima—War Department, Twentieth St. and Constitution Ave., N. W., Washington, D. C., has authorized a new air force training school in vicinity of Yakima. A boiler house will be built; also, power substation, with complete electrical distribution system for light and power service. Entire project will cost over $3,000,000, and will be carried out under direction of U. S. District Engineer Office, Seattle, Wash.

Wis., Beloit—Wisconsin Power & Light Co., Madison, Wis., has completed plans and made application for priority rating for proposed addition to steam-electric generating station at Beloit, including new brick and steel building, and installation of turbine-generator unit and auxiliaries, boiler equipment, etc., for increased capacity. Entire project will cost close to $2,500,000. Sargent & Lundy, Inc., 140 South Dearborn St., Chicago, Ill., is consulting engineer.

MURRAY

• TYPE U •

SINGLE STAGE TURBINES FOR MECHANICAL DRIVE



Among the improved design features that have won wide acceptance of this MURRAY Turbine are:

- **Special casing design permits rotor to be removed without breaking steam inlet or exhaust pipe joints.**
- **Turbine cover can be easily removed without disturbing the mechanical condition of the turbine.**
- **Flexible front end support allows for axial expansion and contraction.**
- **Hand valves, with air cooled hand wheels, deep stuffing boxes provide for: Overload; normal load with reduced steam condition; maximum economy at partial loads, condensing and non-condensing.**
- **Self-closing, dust-proof oil cup for inspecting oil ring and filling oil reservoir.**
- **Bronze backed babbitt lined bearing designed for effective lubrication at all speeds.**

For complete details of construction and performance of MURRAY Type "U" Turbines write for Bulletin T-118.

MURRAY IRON WORKS COMPANY — BURLINGTON, IOWA

BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

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Air Preheater Corp.
Babcock & Wilcox Company, The
Bros Boiler & Mfg. Co., Wm.
Combustion Engrg. Co., Inc.
Foster Wheeler Corporation
Green Fuel Economizer Co.

AIR WASHERS
American Blower Corp.

ANTI-CORROSIVE COATINGS
Dampney Co. of Amer.
Haering & Co., Inc., D. W.

ANTI-FRICTION METAL
Magnolia Meatal Co.

ARCHES, BOILER & COMBUSTION
Carborundum Co., The

BAFFLES, BOILER
Engineer Co., The

BEARING METAL
Magnolia Metal Co.

BELTS, V TYPE
Gilmer Co., L. H.

BELTING, RUBBER
Gilmer & Co., L. H.

BELTING, SILENT CHAIN
Morse Chain Co.

BLOWERS, FAN AND FURNACE
American Coal Burner Co.
De Laval Steam Turbine Co.
Green Fuel Economizer Co.

BLOWERS, FORCED DRAFT, PORTABLE, PRESSURE & COAL
Ideal Commutator Dresser Co.

BLOWERS, TURBINE
Elliott Company
Terry Steam Turbine Co., The

BOILER BLOW-DOWN SYSTEMS
Cochrane Corporation
Elgin Softener Corp.
Henszey Company
Infilco Incorporated
National Aluminate Corp.

BOILER COMPOUNDS
Bird-Archer Co., The
Buromin Co., The
Dearborn Chemical Company
Electric Chemical Co.
Haering & Co., Inc., D. W.

BOILER FEED WATER PURIFYING APPARATUS
Cochrane Corp.
Elgin Softener Corp.
Graver Tank & Mfg. Co., Inc.
Infilco Incorporated
Permutit Co., The

BOILER SETTINGS
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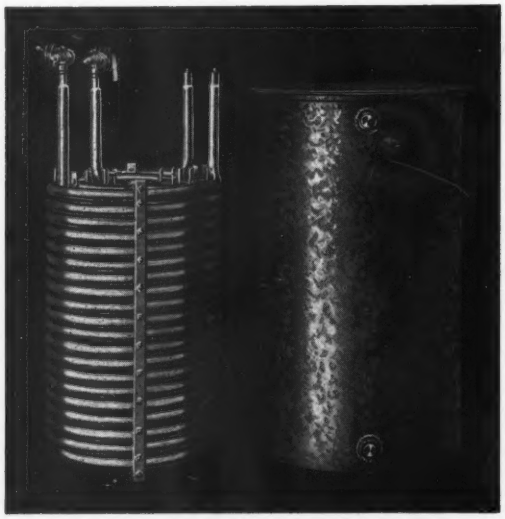

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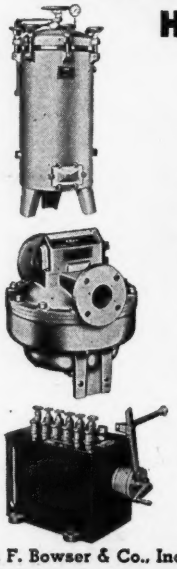

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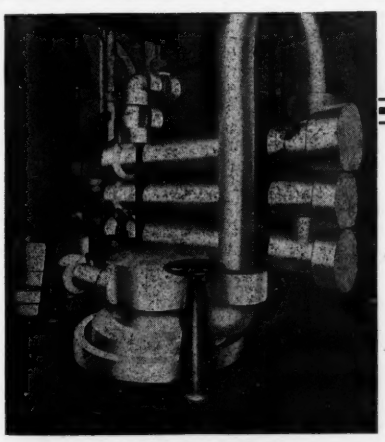

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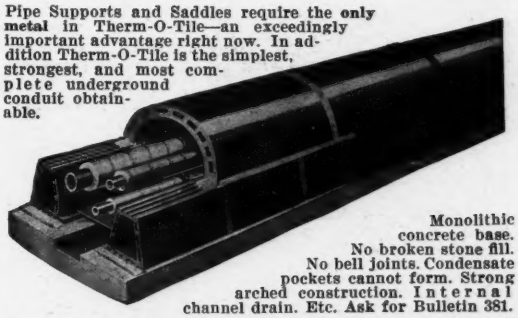

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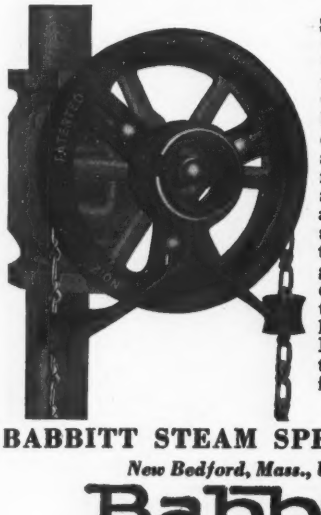

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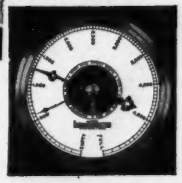

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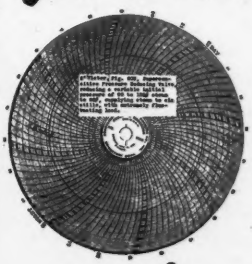

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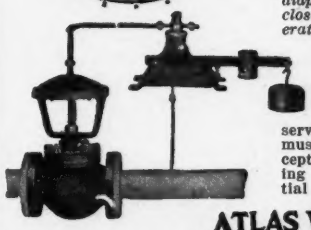

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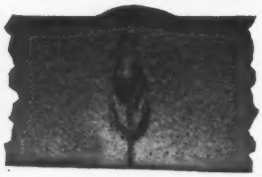

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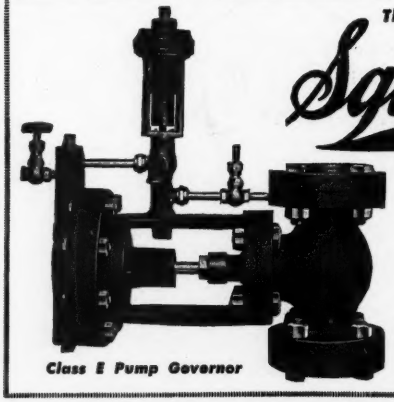

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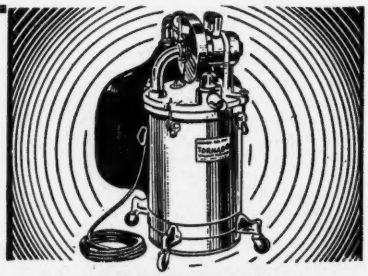

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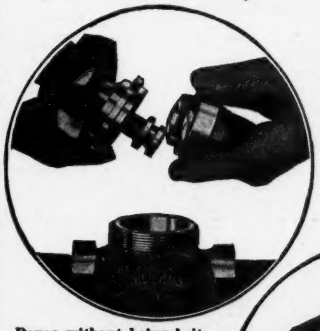

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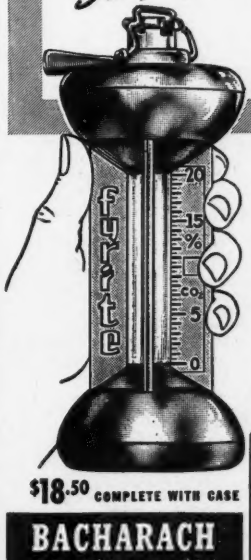

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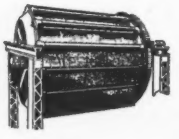

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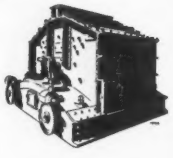

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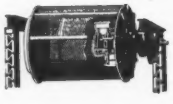

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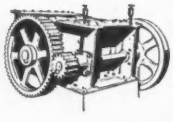

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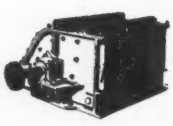

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Allis-Chalmers Mfg. Co.
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Ernst Water Column & Gage Co.
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Combustion Engrg. Co., Inc.
Foster Wheeler Corporation
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Beaumont Birch Co.
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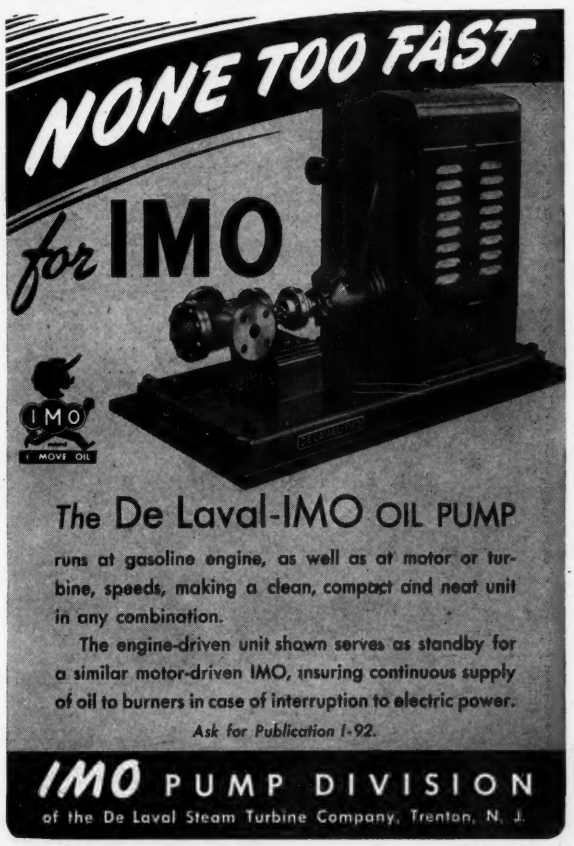
Kellogg Co., The M. W.
Midwest Piping & Supply Co.
National Valve & Mfg. Co.
Tayor Forge & Pipe Wks.

WHISTLES
Lunkenheimer Co., The



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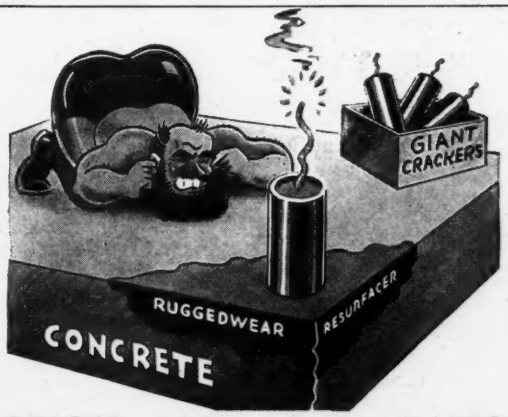

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INDEX TO Advertisers

Airetool Manufacturing Co. ... *
Air Preheater Corp. ..... *
Allis-Chalmers Mfg. Co. 25
American Blower Corp. 45
American Chain & Cable Co., Inc. 137
American Chimney Corp. 152
American Coal Burner Co. 150
American Colloid Co. ..... *
American District Steam Co. ...160
American Engrg. Company.... ..... 16-17, 23
American Pipe Bending Machine Co., Inc. ..... *
American Pulverizer Co. 38
American Radiator & Standard Sanitary Corp. 45
Anderson Co., The V. D. ..... *
Armstrong Machine Works... 14
Askania Regulator Co. ..... *
Atlas Lumnite Cement Co., The.179
Atlas Valve Company.....173

Babbitt Steam Specialty Co. ...172
Babcock & Wilcox Co., The....4-5
Bacharach Ind. Inst. Co. 175
Bailey Meter Co. 22
Baldwin De La Vergne Sales Corp. ..... *
Baldwin Locomotive Works.... *
Beaumont Birch Company.....144
Belmont Pkg. & Rubber Co., The ..... *
Bendix Aviation Corp. ..... *
Betz, W. H. & L. D. ..... *
Biddle Co., James G. 124
Bird-Archer Co., The.....147
Borg-Warner Corp. 33
Bowser & Co., Inc., S. F. 170
Breuer Electric Mfg. Co. 174
Bros Boiler & Mfg. Co., Wm. .. *
Brown Instrument Co., The.... *
Brunt Equipment Co. ..... *
Burgess Battery Co. ..... *

Canton Stoker Corp. ..... *
Carborundum Company, The... *
Cash Company, A. W. 149
Chapman Valve Mfg. Co., The.. .....Inside Back Cover
Cities Service Oil Co. 41
Cochrane Corporation..44, 136, 152
Combination Pump Valve Co. .146
Combustion Engrg. Co., Inc. .42-43
Corning Glass Works.....130
Crane Co. 133
Crane Packing Company.....153
Cutler-Hammer, Inc. ..... *

Dampney Company of America, The ..... *
Dart Mfg. Co., E. M. 126
Davis Regulator Co. ..... *
Dearborn Chemical Co. 29
DeLaval Steam Turbine Co. ... .123, 177
Detroit Stoker Co. ..... *
Dodge Mfg. Corp. ..... *

Edward Valve & Mfg. Co., Inc., The 115
Ehret Magnesia Mfg. Co. ..... *
Electric Chemical Co. ..... *
Elgin Softener Corp. ..... *
Elliott Co. 2-3
Engineer Co., The.....142
Ernst Water Column & Gage Co.138
Everlasting Valve Co. 132

Fairbanks Co., The.....127
Fisher Governor Company..... 39
Flexrock Co. 177
Flynn & Emrich Co. 161
Foster Engrg. Company..... *
Foster Wheeler Corp. 12-13
France Packing Co. ..... *
Fuller Company 128

Garlock Packing Co., The..... 28
General Coal Company..... *
General Electric Co. 8-9, 125
Gifford-Wood Co. ..... *
Gilmer Company, L. H. 121
Globe Steel Tubes Co. ..... *
Golden-Anderson Valve Specialty Co. 152
Graver Tank & Mfg. Co., Inc. .139
Green Fuel Economizer Co. ...155
Grinnell Co., Inc. 122

Haering Co., D. W. 148
Hagan Corporation 6-7, 20-21
Hall Laboratories, Inc. ..6-7, 20-21
Hays Corporation, The..... *
Henszey Company 171
Huyette Co., Inc., The Paul B.. *

Ideal Commutator Dresser Co.. *
Infilco, Incorporated 159
International Nickel Co. 47
Iron Fireman Mfg. Co. 30-31

Johns-Manville 145

Kellogg Co., The M. W. 131
Kennedy Valve Mfg. Co., The..143

Leavitt Machine Co. 157
Leeds & Northrup Company... 32
Link-Belt Company 165
Liquidometer Corp., The.....173
Lummus Co., The..... 37
Lunkenheimer Co., The.....113

Magnolia Metal Co. 142
Manzel Bros. Co. 176
Marley Company, The..... *
Midwest Piping & Supply Co., Inc. 15
Minneapolis-Honeywell Reg. Co. *
Missouri Boiler & Sheet Iron Wks. ..... *
Morse Chain Co. 33
Murray Iron Works Co. 169

National Aluminate Corp. 111
National Valve & Mfg. Co. .... *
Nicholson & Co., W. H. 144
Northern Equipment Co. 34
Nugent & Co., Inc., Wm. W. ... *

For handy classified listings of power equipment and supplies see Where-To-Buy directory on preceding pages

Peabody Engrg. Corp. ..... *
Pennsylvania Crusher Co. 176
Pennsylvania Pump & Comp. Co. ..... *
Permutit Co., The.....Back Cover
Pomona Pump Co. ..... *
Porter & Co., Inc., H. W. 171
Powell Co., The Wm. 135
Pritchard & Co., J. F. 151
Proportioneers, Inc. ..... *

Quimby Pump Co. ..... *

Raybestos-Manhattan, Inc. .... *
Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc. 137
Reliance Gauge Column Co. ...164
Rempe Co. 170
Republic Flow Meters Co. 24
Republic Steel Corporation..... *
Richardson Scale Company.... *
Ric-Wil Company, The.....158
Roto Company, The.....138
R-S Products Corp. 134

Sarco Company, Inc. ..... *
Sauerman Bros., Inc. 168
Scovill Mfg. Co. 10-11
Shell Oil Co., Inc. 129
Simplex Valve & Meter Co. ... *
Smooth-On Mfg. Co. 162
Socony-Vacuum Oil Co., Inc... *
Springfield Boiler Co. 18-19
Squires Co., The C. E. 174
Standard Oil Co. (Indiana)..35-36
Steel and Tubes Division..... *
Strong, Carlisle & Hammond Co., The 154
Sun Oil Company.....117
Swartwout Co., The..... *
Syntron Company ..... *

Taylor & Co., W. A. 150
Taylor Forge & Pipe Works...141
Terre Haute Boiler Works Co..172
Terry Steam Turbine Co. 40
Texas Co., The..... 48
Tide Water Associated Oil Co.. *
Treasury Department 156, 167
Troy Engine & Machine Co. ..180
Tube-Turns, Inc. 119

United States Steel Corp. 179

Vogt Machine Co., Inc., Henry. 46

Wahl Refractory Prod. Co. ...172
Warren Steam Pump Co., Inc.. *
Watson-Stillman Co., The.....166
Wedge Protectors, Inc. 174
Westinghouse Elec. & Mfg. Co. *
Wickes Boiler Co., The..... *
Williams Valve Co., The D. T..175
Wilson Chemical Feeders, Inc..140
Worthington Pump & Machy. Corp. 163

Yarnall-Waring Co. 26-27, 50

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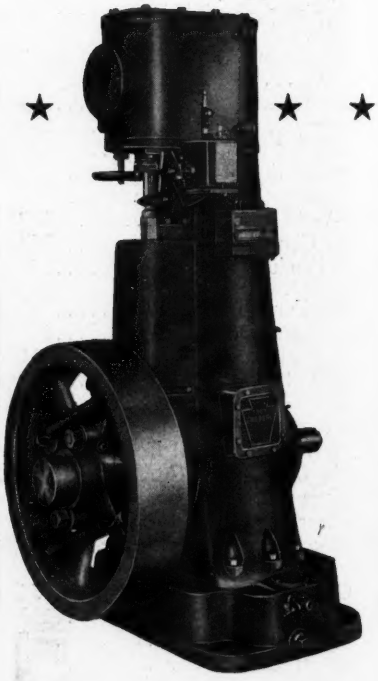

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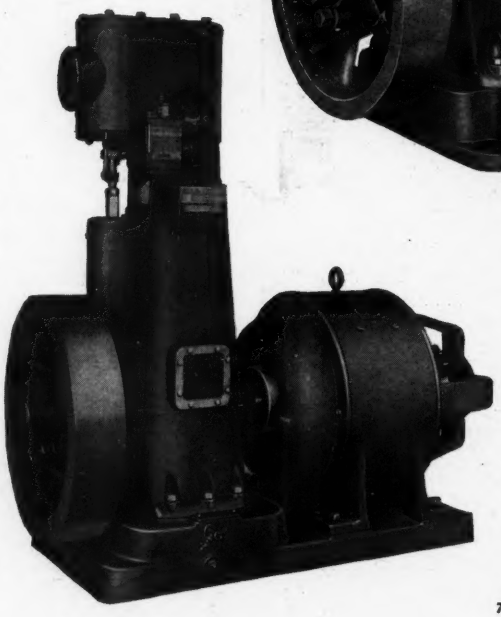

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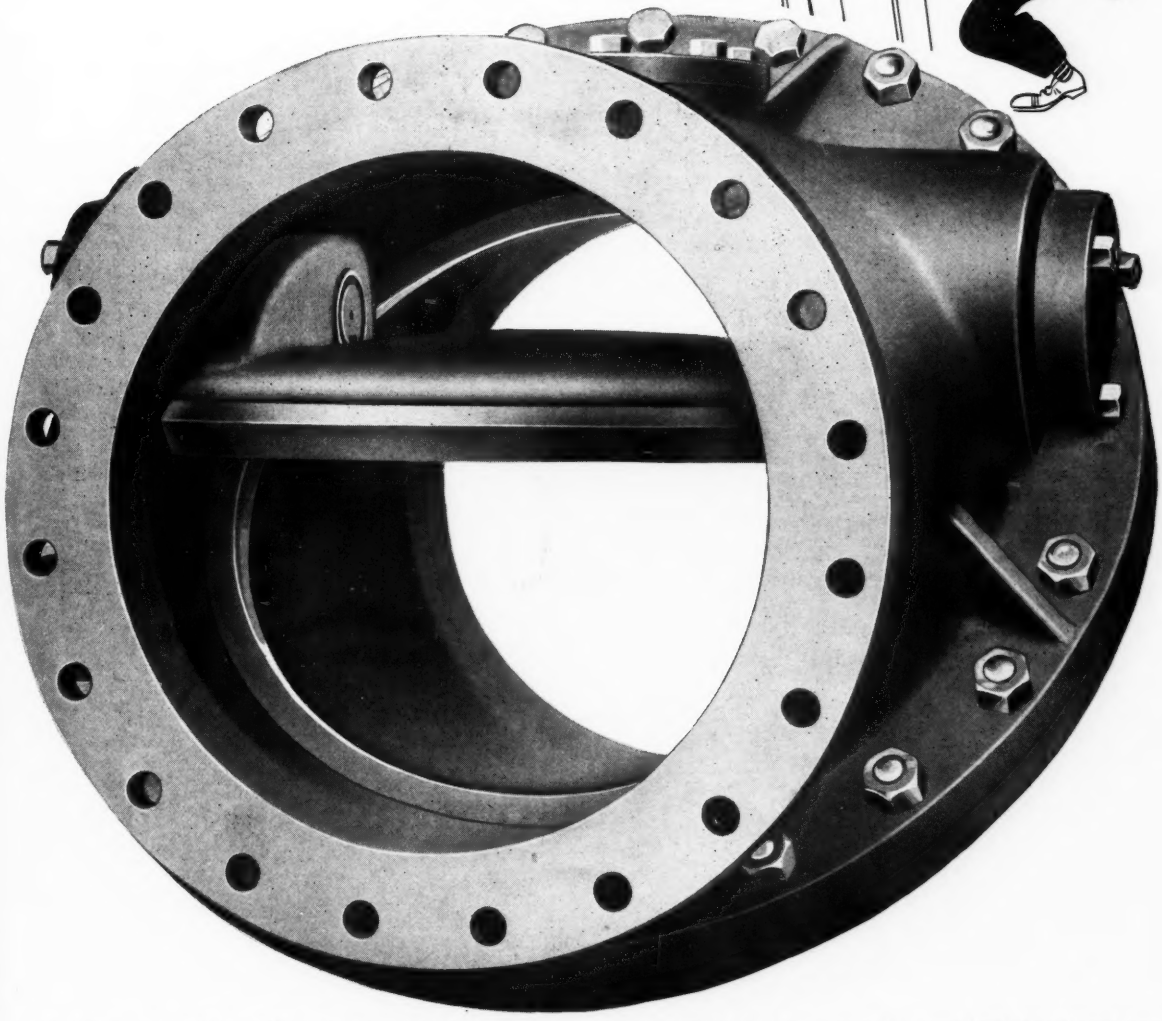

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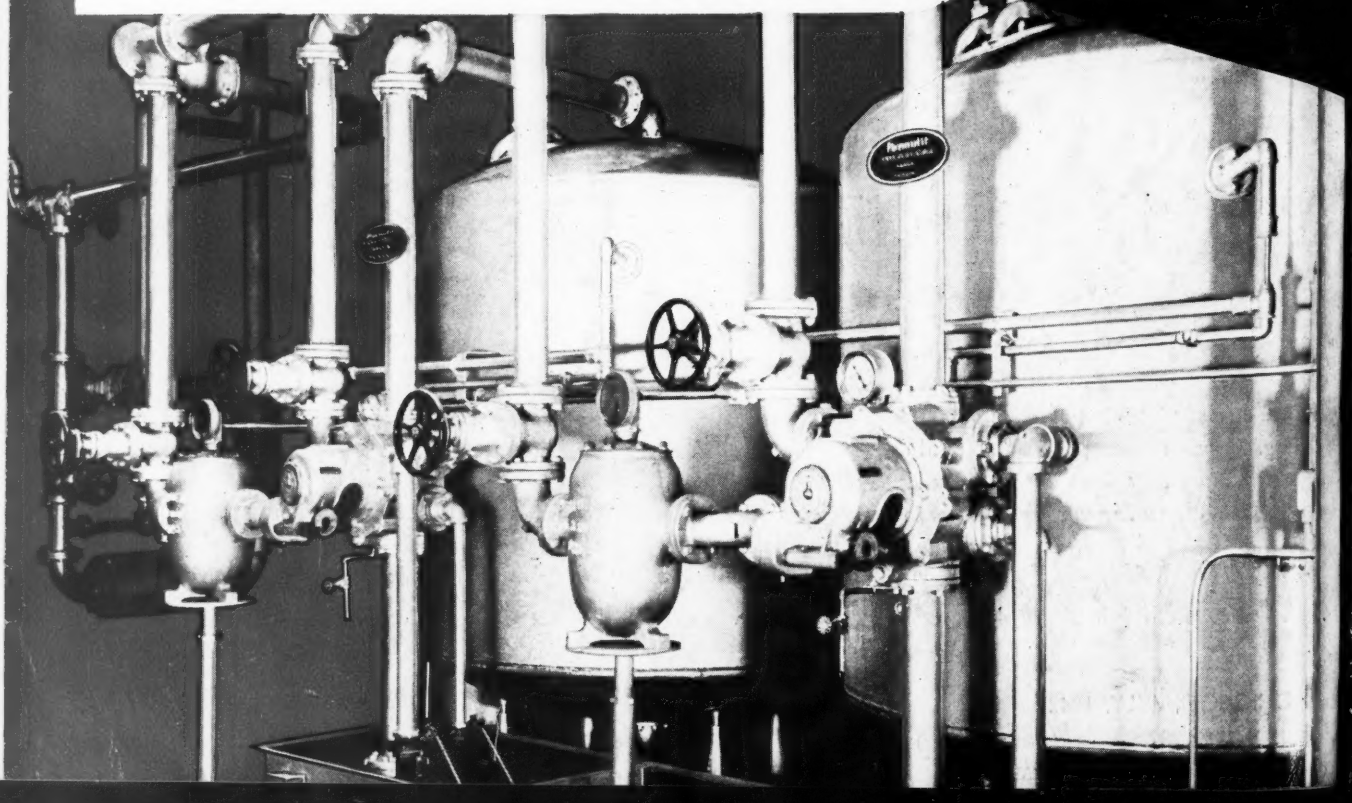
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